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Kundendienst

Service Manual TNC 150

Subject to change (without notice)

DR. JOHANNES HEIDENHAIN GmbH is constantly working on further developments of its TNC Controls. It is therefore possible that details of your Control may differ slightly from those described herein. If that is the case, please order a suitably revised issue of the Service Manual.

Copying/Duplication

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C o n t e n t s

1. Use of the Service Manual TNC 150

In order to determine the fault condition on an NC machine, a fundamental knowledge of the machine and the drives is necessary, as well a a knowledge of their interaction with the Control and measuring system. In addition, improper use of the Control, such as incorrect NC programming or incorrect selection of machine parameters can lead to the occurrence of fault conditions. Further information in this respect can be found in:

.TNC 150 OPERATING MANUAL
.TNC 150 MOUNTING INSTRUCTIONS AND INTERFACE CIRCUIT CONTROL-MACHINE
.TNC 150 PLC-DESCRIPTION

The TNC 150 Service Manual is used for the diagnosis, localisation and remedying of faults on TNC controlled machines.
In chapter 2, Fault Diagnosis, a set of flowcharts enables the user to pinpoint the source of a fault from its symptoms.
An inbuilt supervision system and a BURN-IN Test Program specifically developed for testing the Control can aid in the location of faults.
Important guidance for the exchange of entire Controls, individual boards, or software is given in section 3, Exchange Information.
Section 4, Additional Information, contains a block diagram of the Control, a wiring diagram for each version of the Control, and a list of machine parameters with permissible entry values.

2. Fault Diagnosis

2.1 Procedure for fault-finding

For fault diagnosis of the Control/machine it is of prime importance to analyse the behaviour of the installation as a whole.

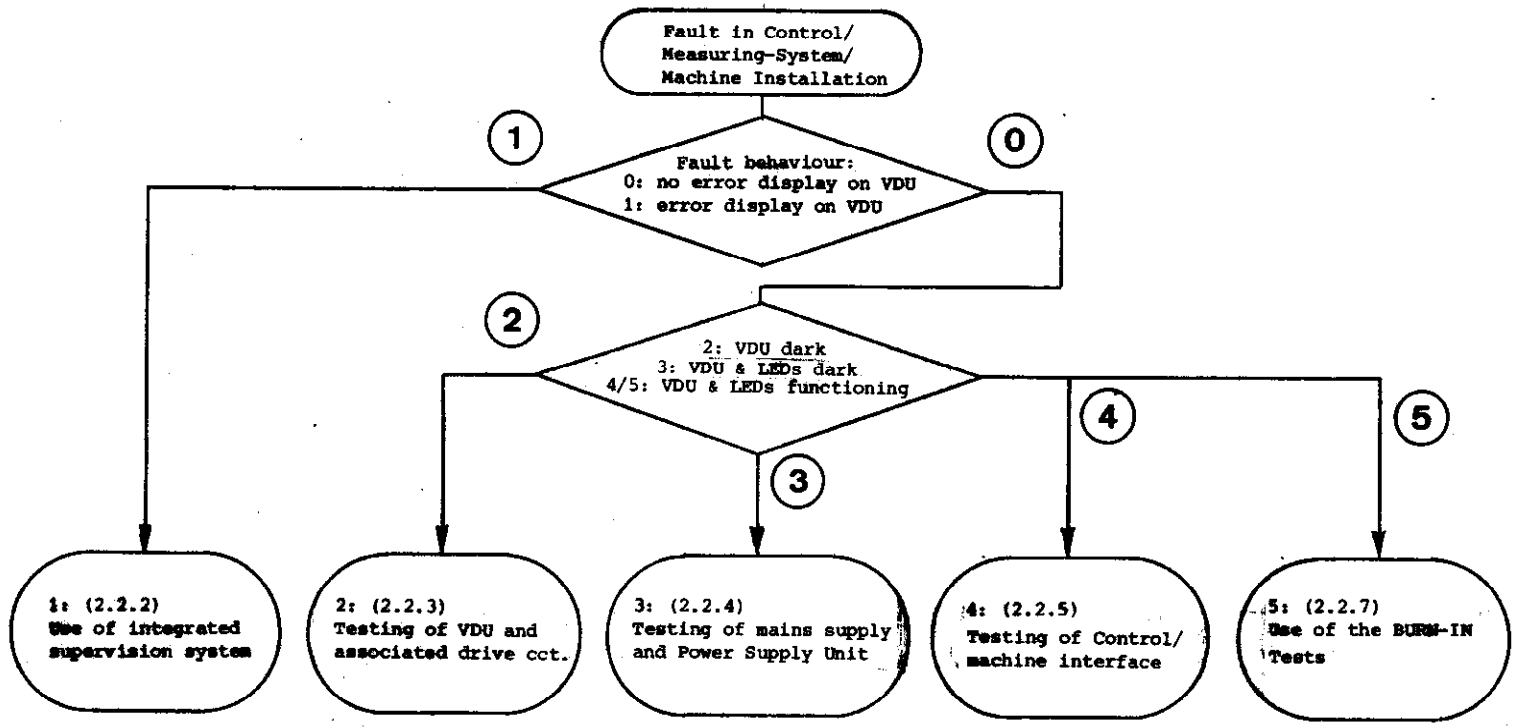
When fault finding, the solutions should be determined using the flowcharts provided in this document. Starting from the initial apparent fault, the symptoms of the fault should be analyzed in order to pinpoint the cause of failure (see section 2.2).

In addition, the HEIDENHAIN TNC 150 Contouring Control includes an extensive integrated supervision system for the avoidance of entry/operator faults and for the recognition and diagnosis of technical defects on the machine/Control system (see section 2.2).

The BURN-IN Test Program and the Test Program TNC 150 can be used as further support in fault localizing and in the dynamic testing of the Control's hardware (see section 2.2.7).

2.2 Flow diagrams for fault location

2.2.1 Fault diagnosis for the complete installation (Control/Measuring-System/Machine)



2.2.2 Use of the integrated supervision system

The integrated supervision system of the TNC 150 comprises TNC hardware and software. It operates continuously whilst the Control is switched on, and recognizes a major proportion of faults as well as irregularities in the Control and the installation.

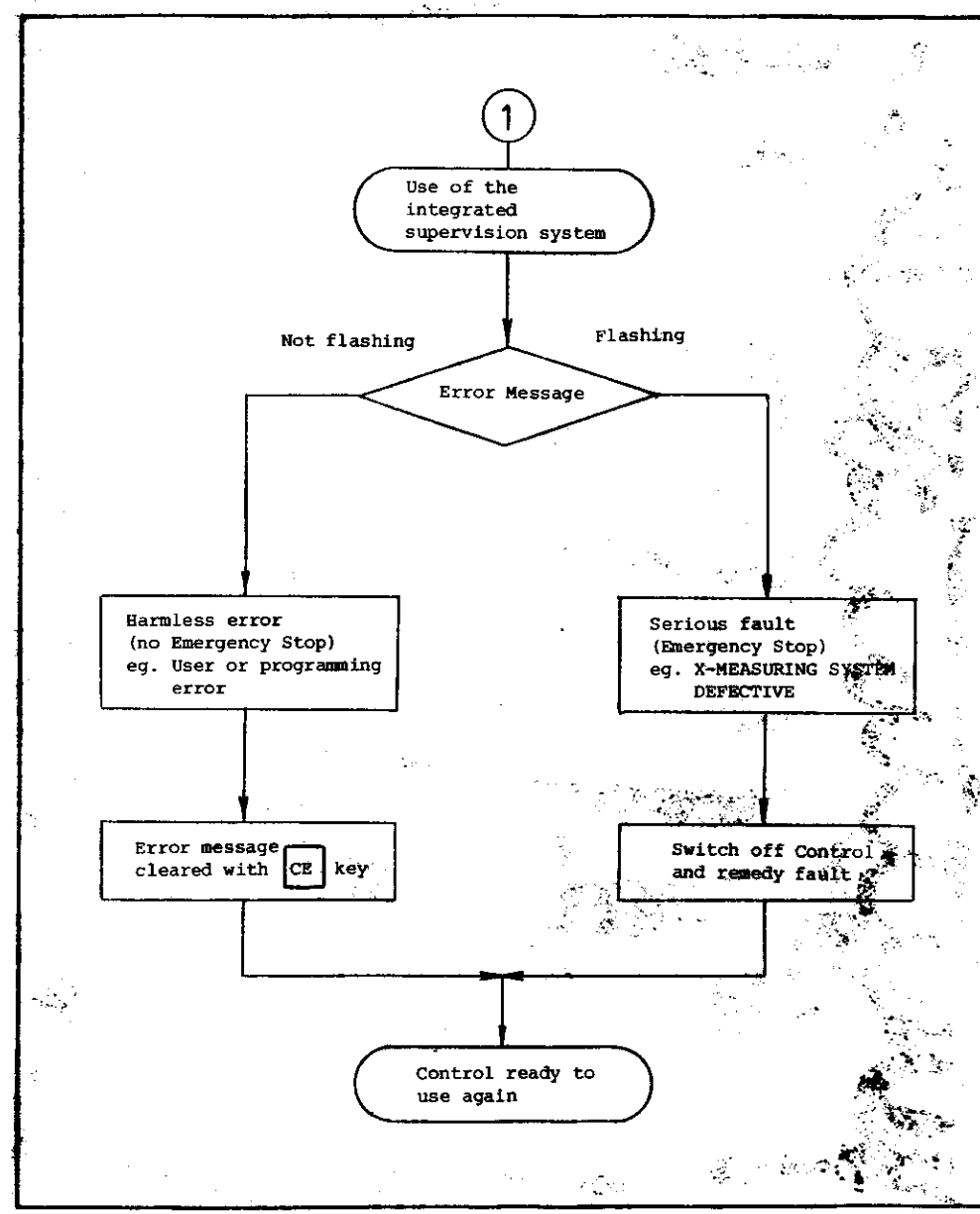
The following are supervised:

.Programming and operator errors
Example error messages:
KEY NON-FUNCTIONAL
CIRCLE END POS. INCORRECT
ENTRY VALUE INCORRECT

.Control's internal electronics
Example error messages:
TNC OPERATING TEMP. EXCEEDED
EXCHANGE BUFFER BATTERY
TNC-ELECTRONICS DEFECTIVE

.Measuring system and certain machine functions
Example error messages:
X-MEASURING SYSTEM DEFECTIVE
GROSS POSITIONING ERROR
RELAY EXT. DC VOLTAGE MISSING

The Control distinguishes between harmless **errors** and serious **faults**, in that **faults** are shown as flashing displays (eg. measuring system faults, drive faults and faults in the Control's electronics). The occurrence of **faults** leads to the machine being switched off via the emergency stop contactor.



Error messages TNC 150

Error messages are **not** followed by an emergency stop and can be cleared with the CE key. Their meanings are explained in "Operating Manual TNC 150 B/TNC 150 Q", and "Mounting Instructions and Interface Circuit Control-Machine TNC 150 B/TNC 150 Q".

KEY NON-FUNCTIONAL
PROGRAM MEMORY EXCEEDED
SEARCH ADDRESS MISSING
TOOL DEF Ø NOT PERMITTED
PROGRAM NUMBER ON TAPE ALLOCATED
JUMP TO LABEL Ø NOT PERMITTED
ENTRY VALUE INCORRECT
CC-BLOCK MISSING
CIRCLE END POS. INCORRECT
TOOL DEF MISSING
TOOL CALL MISSING
LABEL NUMBER NOT ALLOCATED
EXCESSIVE SUBPROGRAMMING
ANGLE REFERENCE MISSING
PLANE WRONGLY DEFINED
TOOL RADIUS TOO LARGE
ROUNDING RADIUS TOO LARGE
PATH OFFSET WRONGLY STARTED
PATH OFFSET WRONGLY ENDED
ROUNDING-OFF UNDEFINED
ROUNDING-OFF NOT PERMITTED
AXIS DOUBLE PROGRAMMED
WRONG RPM
NO EDITING OF RUNNING PGM
RADIUS COMP. UNDEFINED
LIMIT SWITCH X+
LIMIT SWITCH X-
LIMIT SWITCH Y+
LIMIT SWITCH Y-
LIMIT SWITCH AXIS Z+
LIMIT SWITCH AXIS Z-
LIMIT SWITCH AXIS 4+
LIMIT SWITCH AXIS 4-
EXCHANGE BUFFER BATTERY
TRANSFERRED DATA INCORRECT
ME: CASSETTE MISSING
ME: CASSETTE LOCKED
ME: WRONG MODE SELECTED
ME: WRONG PROGRAM DATA
ME: CASSETTE EMPTY
ME: PROGRAM INCOMPLETE
ME: TAPE END
WRONG PROGRAM DATA
MACHINE PARAMETER INCOMPLETE
EXT. IN-/OUTPUT NOT READY
MIRROR IMAGE ON TOOL AXIS
WRONG AXIS PROGRAMMED
WRONG SIGN PROGRAMMED
SPINDLE ROTATES MISSING
SLOT WIDTH TOO LARGE
CYCLE INCOMPLETE
SELECTED BLOCK NOT ADDRESSED
PROGRAM START UNDEFINED
POSITIONING ERROR
EMERGENCY STOP
ARITHMETICAL ERROR
OPERATION PARAMETERS ERASED
3D-INTERPOLATION NOT PERMITTED
FURTHER PROGRAM ENTRY IMPOSSIBLE
PROGRAM NUMBER UNAVAILABLE
PROGRAM NUMBER ALLOCATED
LABEL NUMBER ALLOCATED
TOOL NUMBER ALLOCATED
CONTROL VOLTAGE FOR RELAYS MISSING
POWER INTERRUPTED

Error message **"EXCHANGE BUFFER BATTERY"**

If the dialogue display indicates "EXCHANGE BUFFER BATTERY", new batteries must be inserted (discharged batteries support the program contents for at least 1 week). The buffer battery compartment is located beneath the screw cover in the lower left-hand corner of the operating panel (see section C). When exchanging the batteries, special care should be taken when inserting, that the polarity is correct (POS-pole of battery outwards). The batteries to be used have IEC designation "LR 6" and must be of the leak-proof type. We especially recommend the use of VARTA Alkaline batteries type "4006". With discharged (or missing) buffer batteries, the memory for the machine parameters and for the user-program will be supported as long as the mains remains switched on. Continued operation is still possible but the memory contents will become erased in the event of a mains power failure. Please note that the TNC has to be switched on when exchanging the buffer batteries. If a mains power failure occurs during a battery change (discharged or missing batteries), new entry of the machine parameters and user program is necessary.

.Flashing fault messages

Important functions of the TNC 150 Control are supervised through self diagnostics (electronic sections such as µP, EPROM, RAM, positioning system, transducer system etc.)
If a fault is detected, a **flashing** plain language fault message will appear in the **dialogue display** and is followed by the opening of the **emergency-stop** contact. This condition can be reset by switching-off the Control, eliminating the fault and then switching the Control on again.

.Flashing fault messages TNC 150

AXIS X/Y/Z/4 MEAS. SYSTEM DEFECTIVE

EMERGENCY STOP DEFECTIVE

WRONG REFERENCE POINT

SWITCH POWER OFF, THEN ON AGAIN

EMERGENCY STOP PLC

GROSS POSITIONING ERROR A/B

TNC OPERATING TEMP. EXCEEDED

ERROR IN PLC PROGRAM A...Q

TNC ELECTRONICS DEFECTIVE 0...3/A...K

CHECK SUM ERROR XX00...XXFF

Fault descriptions TNC 150

VDU Display (flashing)	Fault cause	Possible fault location
X-MEASURING SYSTEM DEFECTIVE Y-MEASURING SYSTEM DEFECTIVE Z-MEASURING SYSTEM DEFECTIVE AXIS 4 MEAS. SYSTEM DEFECTIVE	.Measuring system not connected .Cable damaged .Glass scale dirty or damaged .Scanning head damaged .Measuring system supervision damaged	Measuring system Analogue Board
RELAY EXT. DC VOLTAGE MISSING	.Machine voltage (+24V) missing (for checking routine, see Mounting Instructions and Interface Circuit Control-Machine manual TNC 150 B/ TNC 150 Q page 19 and 20) .Supervision circuit defective	PLC I/O Board (TNC 150 P/Q) PLC Interface Board (TNC 150 P/Q) SE Board (TNC 150 A/B) Terminal Board (TNC 150 A/B)
EMERGENCY STOP DEFECTIVE	.Fault in the emergency stop circuit of the machine (for checking routine see Mounting Instructions and Interface Circuit Control-Machine manual TNC 150 B/TNC 150 Q page 19/20) Defect in Control's internal Emergency Stop supervision	Analogue Board PLC I/O Board (TNC 150 P/Q) PLC Interface Board (TNC 150 P/Q) SE Board (TNC 150 A/B) Terminal Board (TNC 150 A/B)
WRONG REFERENCE POINT	.Traversed-over reference point lies outside the reference point end-position (also see Mounting Instructions and Interface Circuit Control Machine TNC 150 B/TNC 150 Q, pg.20,21,22 .Defect in Control/machine interface	**Machine (cams/switches "reference end position" or "reference pulse inhibit")** PLC I/O Board (TNC 150 P/Q) PLC Interface Board (TNC 150 P/Q) SE Board (TNC 150 A/B) Terminal Board (TNC 150 A/B)
SWITCH POWER OFF, THEN ON AGAIN	Changing of machine parameters 12,13, 14,15,60,72,90,170 during operation	

VDU Display (flashing)	Fault cause	Possible fault location
EMERGENCY-STOP PC	With standard PLC program, faulty reply from output A6 ("Lock for spindle on") to input E20 ("reply: Lock for spindle on") Fault message EMERGENCY-STOP PLC appears only when no additional PLC marker is set for the fault message	Terminal Board (TNC 150 A/B)
GROSS POSITIONING ERROR A	.Trailing error with positioning greater than value entered in MP 174. (see Mounting Instructions and Interface Circuit Control-Machine manual TNC 150 B/ TNC 150 Q page 45) .Deviation from the intended position at standstill greater than the value entered in MP 169 (see Mounting Instructions and Interface Circuit Control-Machine manual TNC 150 P/ TNC 150 Q, page 40) .Exceeding the range for the continuous position supervision determined by MP 57. (see Mounting Instructions and Interface Circuit Control-Machine manual TNC 150 B/ TNC 150 Q, page 43) .Relationship between output voltage and traversed distance outside of the defined tolerance. .Defect in the pulse counting section (Control circuitry) after the transducer signal supervision	.Machine .Machine parameter programming Aid: 1. Program MP 54 (acceleration) as small as possible. 2. Adjust rapid travers (as small a trailing error as possible). 3. Gradually increase MP 54. If this does not help: fault in the Control hardware (closed loop) or in the machine
GROSS POSITIONING ERROR B	The Control-calculated analogue output voltage (implied by trailing error) is greater than 10 V	
TNC-OPERATING TEMP. EXCEEDED	.Ambient temperature inside the TNC has exceeded +65°C .Fault in the temperature supervision	Ambient temperature of Control Analogue Board

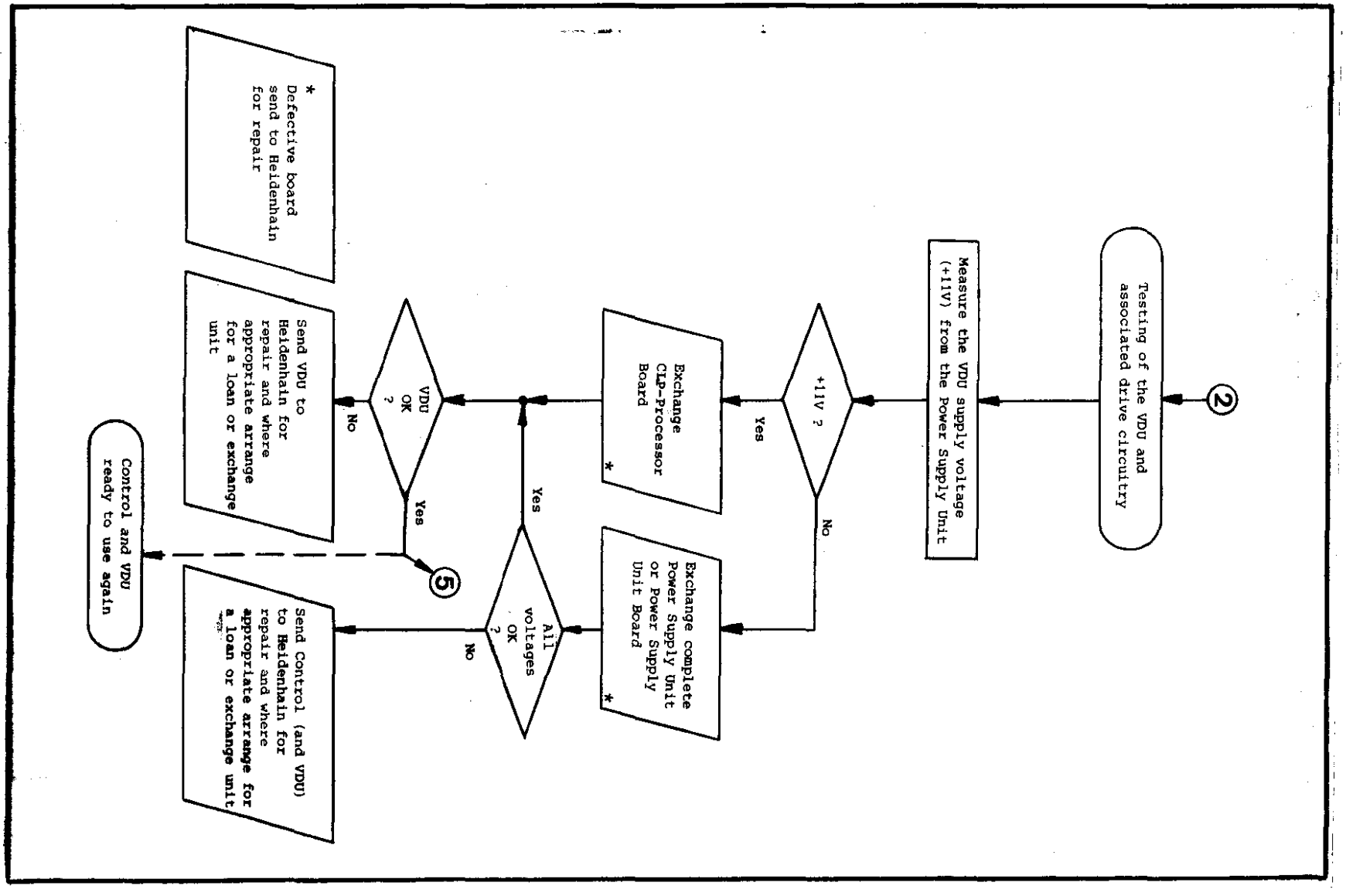
VDU Display (flashing)				Fault cause	Possible fault location
TNC-ELECTRONICS DEFECTIVE			0	False CRC CHECK-SUM* of machine-referred data without machine parameters. (Baud rate, limitation, preset etc)	Main Processor/Memory Board
"	"	"	1	False CRC CHECK-SUM* (machine parameters)	Memory/Main Processor Board
"	"	"	2	False CRC CHECK-SUM (user memory)	Memory/Main Processor Board
"	"	"	3	Integrated Test Program execution incomplete	Main Processor/Memory Board
"	"	"	A	Software error Main Processor	Main Processor Board
"	"	"	B	Software error CLP Processor	CLP Processor Board
"	"	"	C	MID interrupt** CLP Processor	CLP Processor/Main Processor Board
"	"	"	D	CLP Processor instruction stack overflow	CLP Processor Board
"	"	"	E	False instruction: Main Processor ⟶ CLP Processor	CLP Processor/Main Processor Board
"	"	"	F	False instruction (display mode): Main Processor ⟶ CLP Processor	CLP Processor/Main Processor Board
"	"	"	G	CLP Processor RAM (only with TNC 150 B/Q)	CLP Processor Board
"	"	"	H	Overflow interrupt	Main Processor Board
"	"	"	I	MID interrupt Main Processor (only with TNC 150 B/Q)	Main Processor Board
"	"	"	J	Equipped with incorrect language version (only with TNC 150 B/Q)	Main Processor Board
"	"	"	K	RAM EØØØ...FFFF Main Processor (only with TNC 150 B/Q)	Main Processor Board

* CRC = Cyclic Redundancy Check
** MID = Macro Instruction Detection

VDU Display (flashing)	Fault cause	Possible fault location
CHECK-SUM ERROR XX00	CRC CHECK-SUM error with EPROM 4 XX = correct CHECK-SUM value 00 = code for faulty EPROMs	Main Processor Board
" " XX02	CRC CHECK-SUM error with EPROM 5	Main Processor Board
" " XX04	" " " " with EPROM 6,7,8	Main Processor Board
" " XX0A	" " " " with EPROM 9	Main Processor Board (PLC program)
" " XX0B	" " " " with EPROM 9	Main Processor Board (PLC dialogue)
" " XX0C	" " " " with EPROM A	Main Processor Board
" " XX10	" " " " with EPROM B,C,D (EPROM B,C,D,E with TNC 150 A/P)	Memory Board
" " XX16	CRC CHECK-SUM error with EPROM E (not with TNC 150 A/P)	Memory Board
" " XX18	CRC CHECK-SUM error with EPROM F (not with TNC 150 A/P)	Memory Board
" " XX20	CRC CHECK-SUM error with EPROM 2	CLP Processor Board
" " XX21	CRC CHECK-SUM error in RAM area on the CLP Processor Board in which a part of the operating program is stored	CLP Processor Board
" " XXFF	CRC CHECK-SUM error with PLC-RAM PLC Marker 2815 is set	Main Processor Board

CRT display (flashing)	Fault origin	Possible fault location
ERROR IN PLC PROGRAM	Fault with safety-related marker (see PLC-Description manual TNC 150 B/TNC 150 Q pages 36...40)	
" " " " A	Start Key Error with safety-related marker	PLC Program, Main Processor Board
" " " " B	Rapid traverse key	" " " " "
" " " " C	Direction latch key	" " " " "
" " " " D	Feed release	" " " " "
" " " " E	Start PLC positioning X-axis	" " " " "
" " " " F	Start PLC positioning Y-axis	" " " " "
" " " " G	Start PLC positioning Z-axis	" " " " "
" " " " H	Start PLC positioning IV-axis	" " " " "
" " " " I	Direction key X+	" " " " "
" " " " J	Direction key X-	" " " " "
" " " " K	Direction key Y+	" " " " "
" " " " L	Direction key Y-	" " " " "
" " " " M	Direction key Z+	" " " " "
" " " " N	Direction key Z-	" " " " "
" " " " O	Direction key IV+	" " " " "
" " " " P	Direction key IV-	" " " " "
" " " " Q	Undefined macro called-up via PLC marker	" " " " "

2.2.3 Testing of the VDU and the associated drive circuitry



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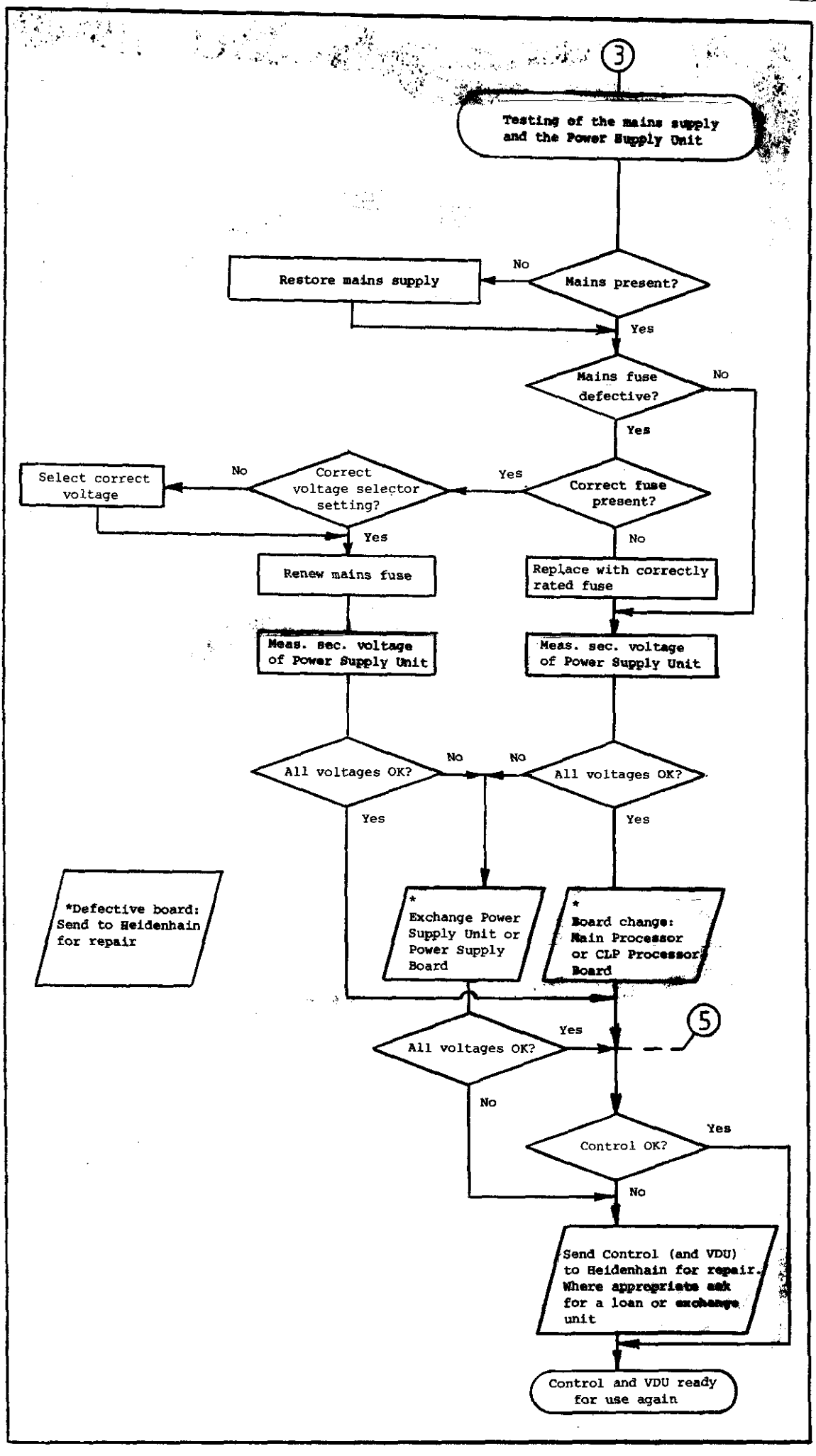
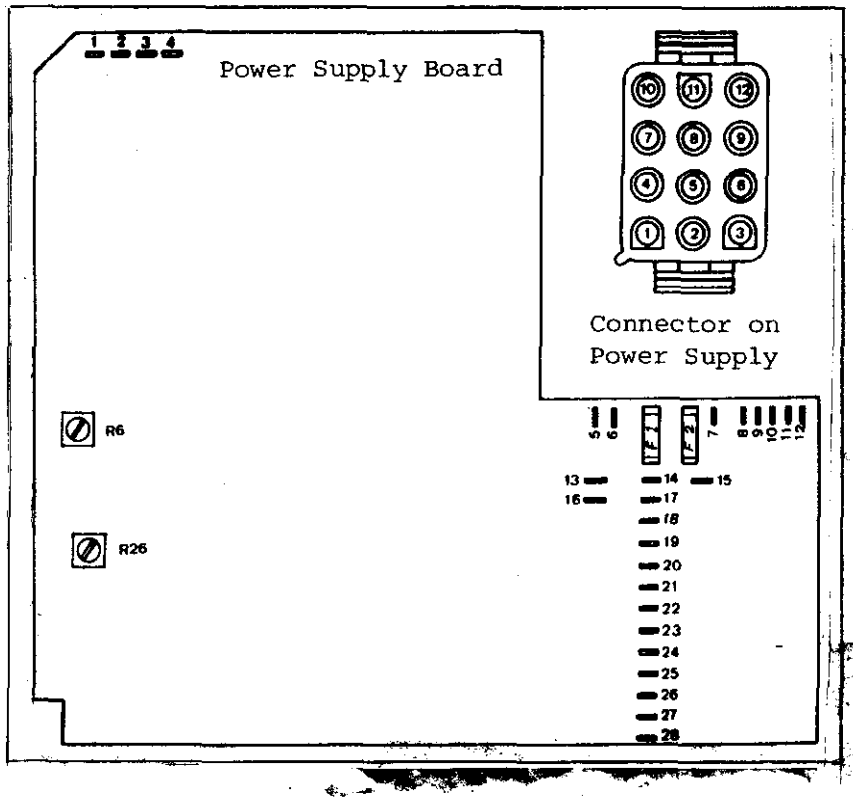
2.2.4 Testing of the mains supply and the Power Supply Unit



Power Supply Test Data

The voltages are to be measured under load
(with board or load unit connected)

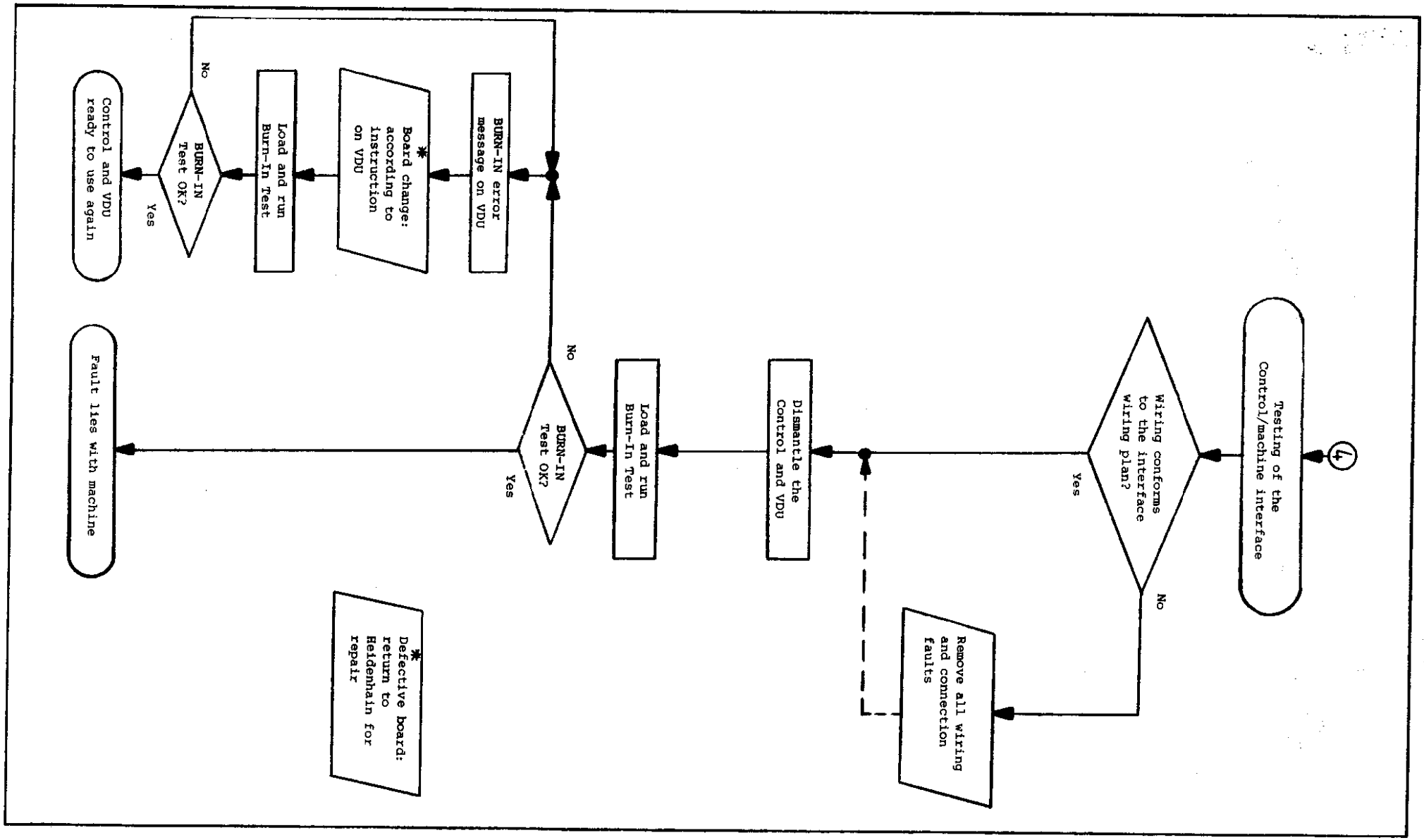


Plug and solder-terminal signal designation

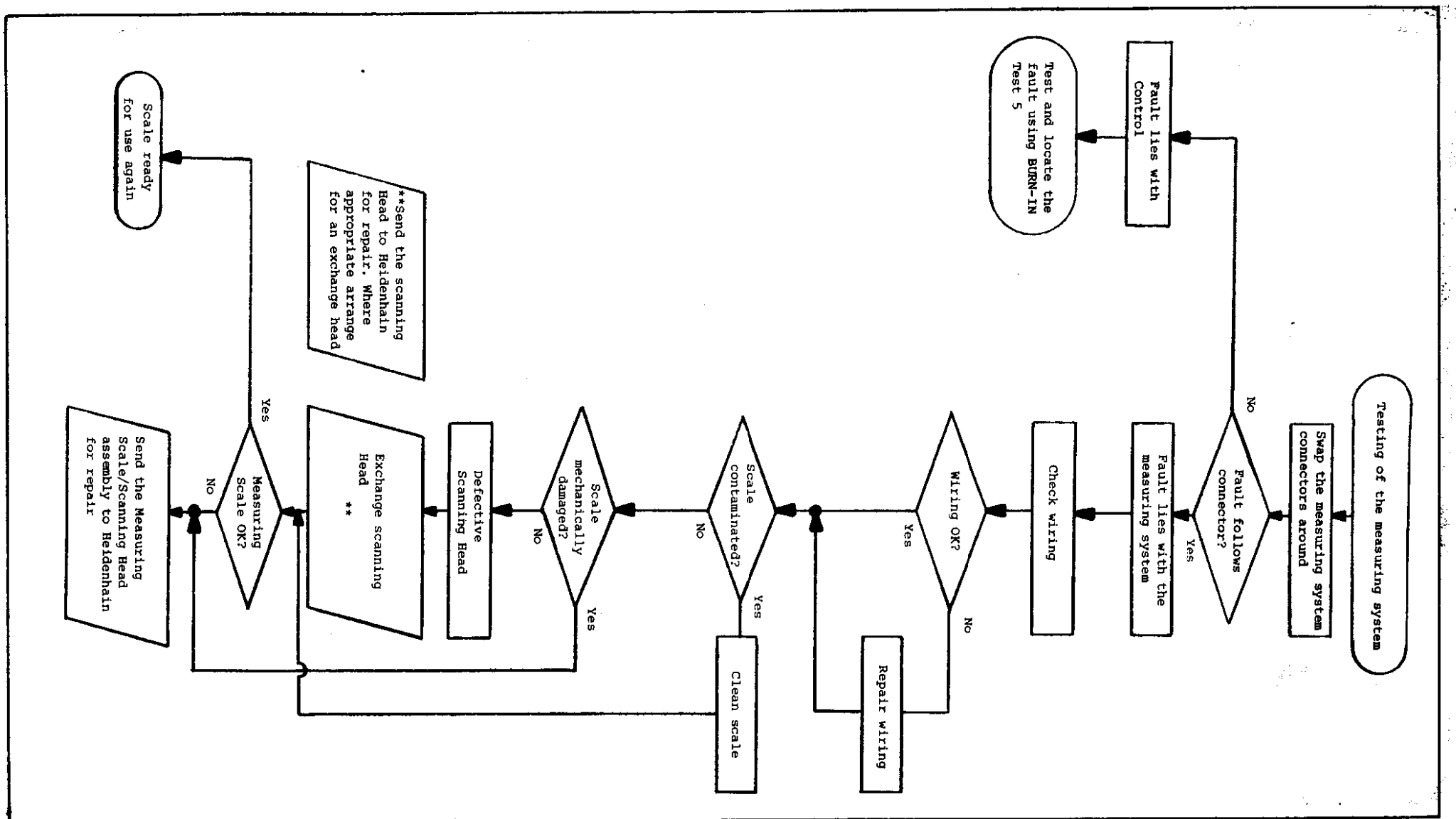
Plug pin	Cable colour	Solder terminal	Voltage/Signal	Test values (V) Under load
1	black	23/24	0V TTL	
2	brown	17	+12 Processor supply	12,0 ± 0,5 at 0,15A
3	red	21/22	+5V TTL	5,16 ± 0,08 at 3,5A
4	grey	20	-15V Switching reg.	-14,9 ± 0,6 at 0,1A
5	blue	27/28	0V Display Unit	
6	green	16	+15V Analogue Board	15,0 ± 0,6 at 0,3A
7	yellow	19	+45V Switching reg.	45,2 ± 1,5 at 0,06A
8	white	25/26	+11V Display Unit	11,2 ± 0,25 at 1,4A
9	green/white	13/8	Reset	
* 10	yellow/white	18	+22V Display	21,6 ± 0,8 at 0,01A
* 11	brown/white	15	4,2V ~ Heater	4,2 ± 0,2 at 0,17A
* 12	brown/white	14		
-	-	1	21V ~ Mains transf.	
-	-	2	sec. voltage	
-	-	3	21V ~ Mains transf.	
-	-	4	sec. voltage	
* -	-	5	0V	
* -	-	6	2,1V ~ Mains transf.	
* -	-	7	2,1V ~ sec. voltage	
-	-	9,10,11,12	no connection	

* not used with TNC 150

2.2.5 Testing of the Control/machine interface



2.2.6 Testing of the measuring system



2.2.7 BURN-IN Test

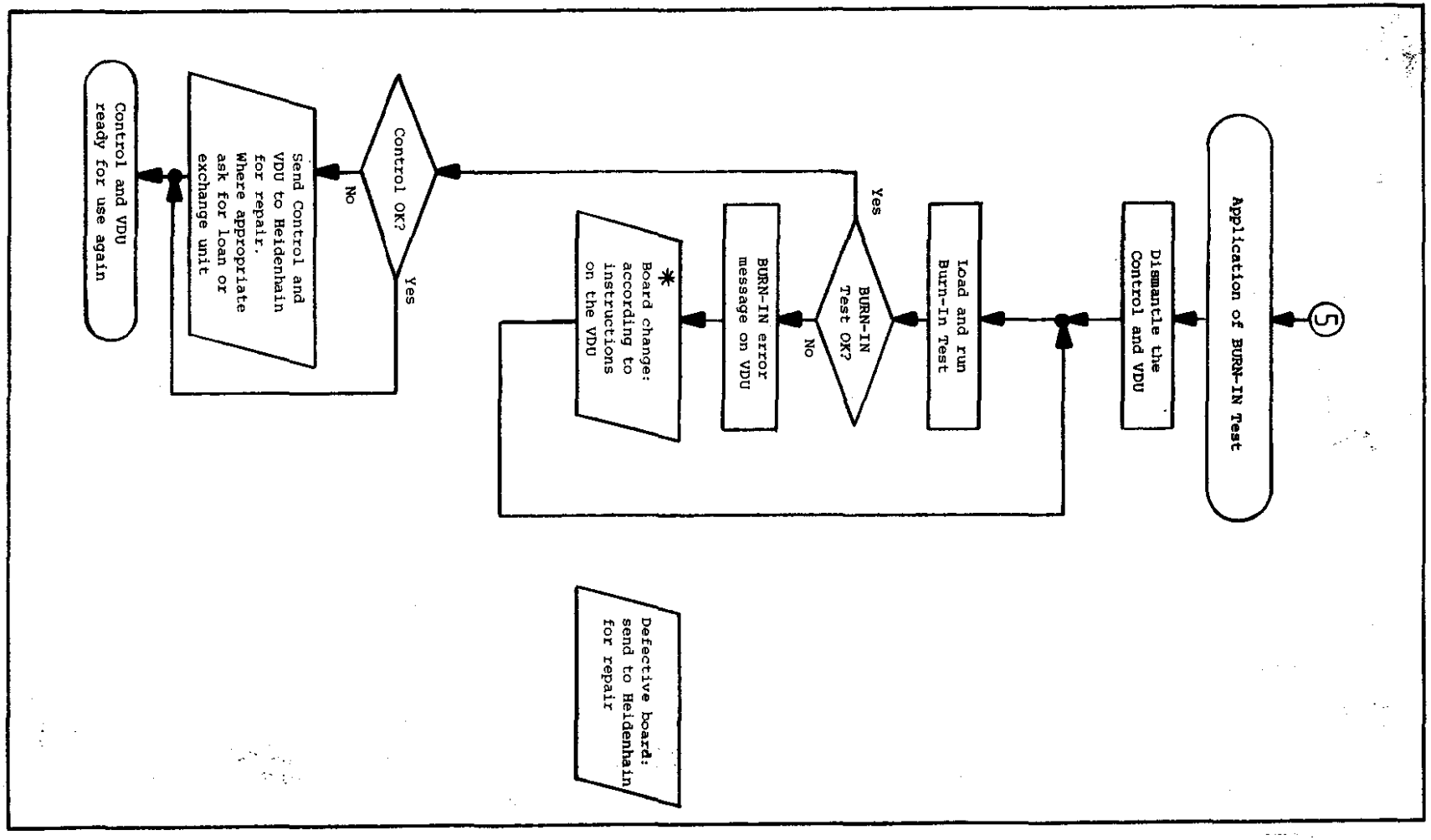
In some cases, inspite of there being definite fault conditions on the Control, error messages may not be displayed on the VDU. However, the Control's electronics can be tested with the help of the BURN-IN Test Program or the Test Program TNC 150.
These Test Programs are a means of dynamically testing the Control's hardware and can be used not only for duration testing but also for fault diagnosis.
These Test Programs are stored on digital cassettes and can be loaded into the Control via magnetic tape units ME 101 B/ 102 B or ME 101 C/102 C (Program versions 212 902 05/ 212 902 07). The Test Programs cannot be loaded into the Control if the flashing error message: "TNC ELECTRONICS DEFECTIVE" is present on the VDU. In this case, the faulty board must be determined by exchanging each board in turn until the fault is eliminated. However, before exchanging any board, it is advisable to check the output voltage from the Power Supply Unit (see section 2.2.4).

To run the Test Programs it is necessary to have a set of BURN-IN Test Adapters.
Depending on the type of Control, (TNC with either a standard interface or with an additional PLC I/O Board) the appropriate adapters must be connected.

Control Type	Test-Adapters (see figure)
TNC 150 A/B/E/F	5,6,7,8,9
TNC 150 P/Q/V/W PLC with bipolar outputs	2,3,4,7,8,10
TNC 150 P/Q/V/W PLC without bipolar outputs	1,3,4,7,8,10

It is necessary to have the correct Test Programs for the Type of Control and for the Control's current software issue. The type of Control can be determined from the type-plate or from the identification number of the Control; the software issue is determined from the NC Software number. The Id. No. of the Control and the NC Software number can be found on the rear of the Control on the type-plate.

Application of the BURN-IN Test/Test Program TNC 150



BURN-IN Test Programs for TNC 150 A/E and TNC 150 B/F

on the Philips digital mini-casette

Control Type	Control Id. No.	NC Software issue	Test dialogue	Test Prog. Id. No.
TNC 150 **A/E**	222 129 99	from... ...04	D	212 958 1A
"	222 129 99	from... ...04	GB	212 959 1A
"	222 129 99	from... ...05	D	212 958 1B
"	222 129 99	from... ...05	GB	212 959 1B
TNC 150 **B/F**	225 012 99	from... ...01	D	212 958 1C
"	225 012 99	from... ...01	GB	212 959 1C

BURN-IN Test Programs for TNC 150 P/V and TNC 150 Q/W

on the Philips digital mini-casette

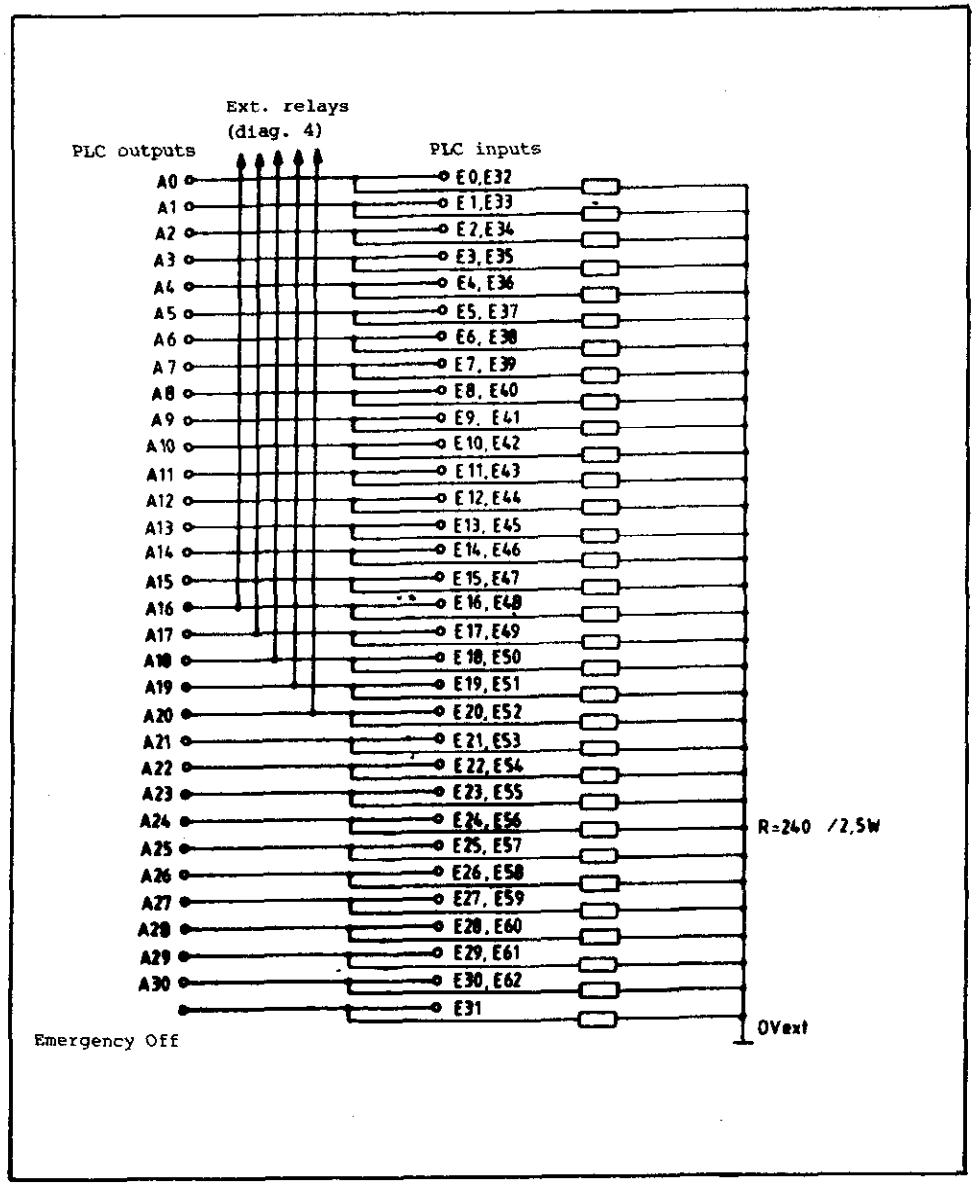
Control Type	Control Id. No.	NC Software issue	Test dialogue	Test Prog. Id. No.
TNC 150 **P/V**	222 128 99	from... ...04	D	212 960 1A
"	222 128 99	from... ...04	GB	212 961 1A
"	222 128 99	from... ...05	D	212 960 1B
"	222 128 99	from... ...05	GB	212 961 1B
TNC 150 **Q/W**	225 013 99	from... ...01	D	212 960 1C
"	225 013 99	from... ...01	GB	212 961 1C

Test Programs TNC 150 B/F

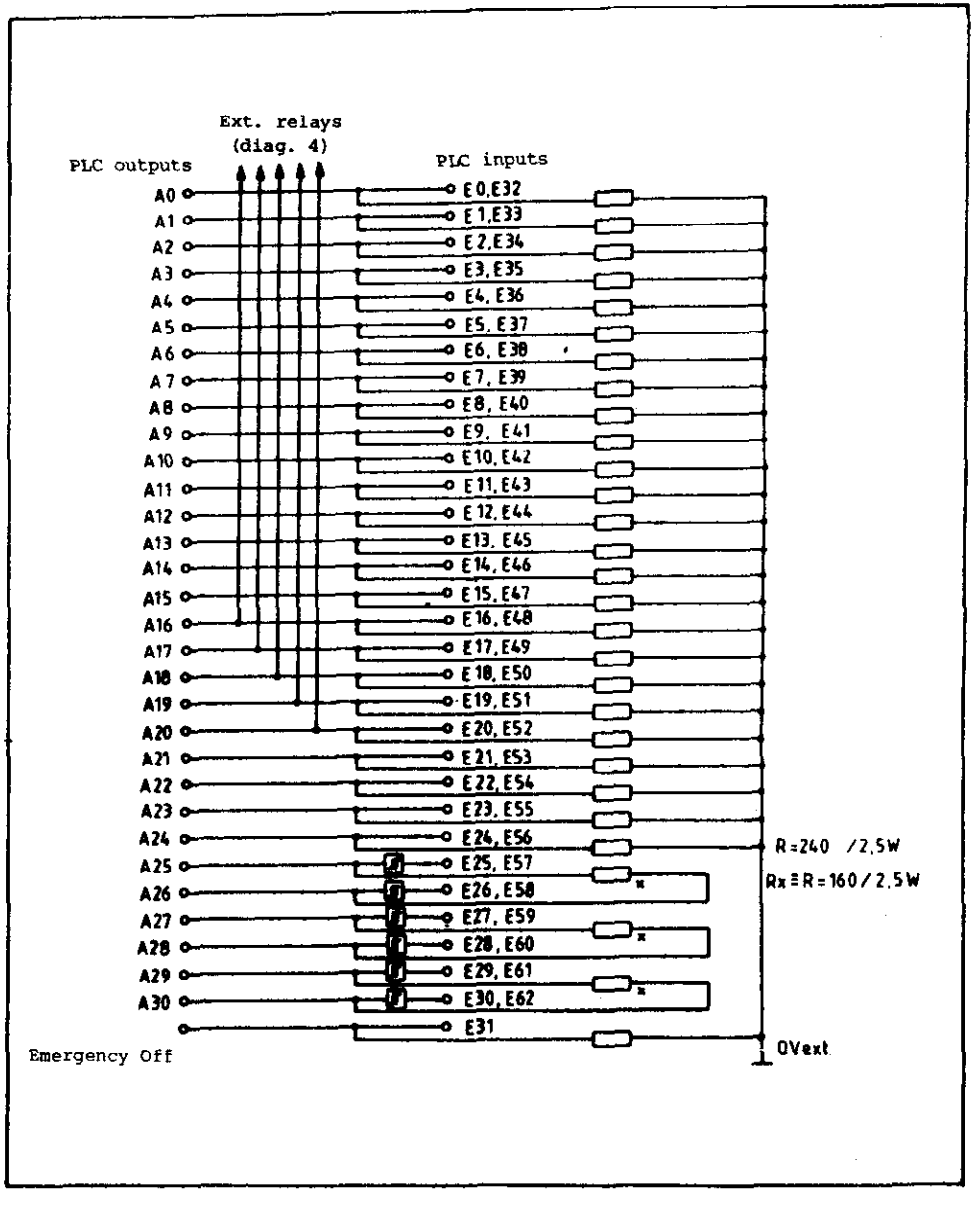
Control Type	Control Id. No.	NC Software issue	Test dialogue	Test Prog. Id. No.
TNC 150 **B/F**	225 012 99	from... ...01	D	227 879 ZY
"	225 012 99	from... ...01	GB	227 881 ZY

Test Programs TNC 150 Q/W

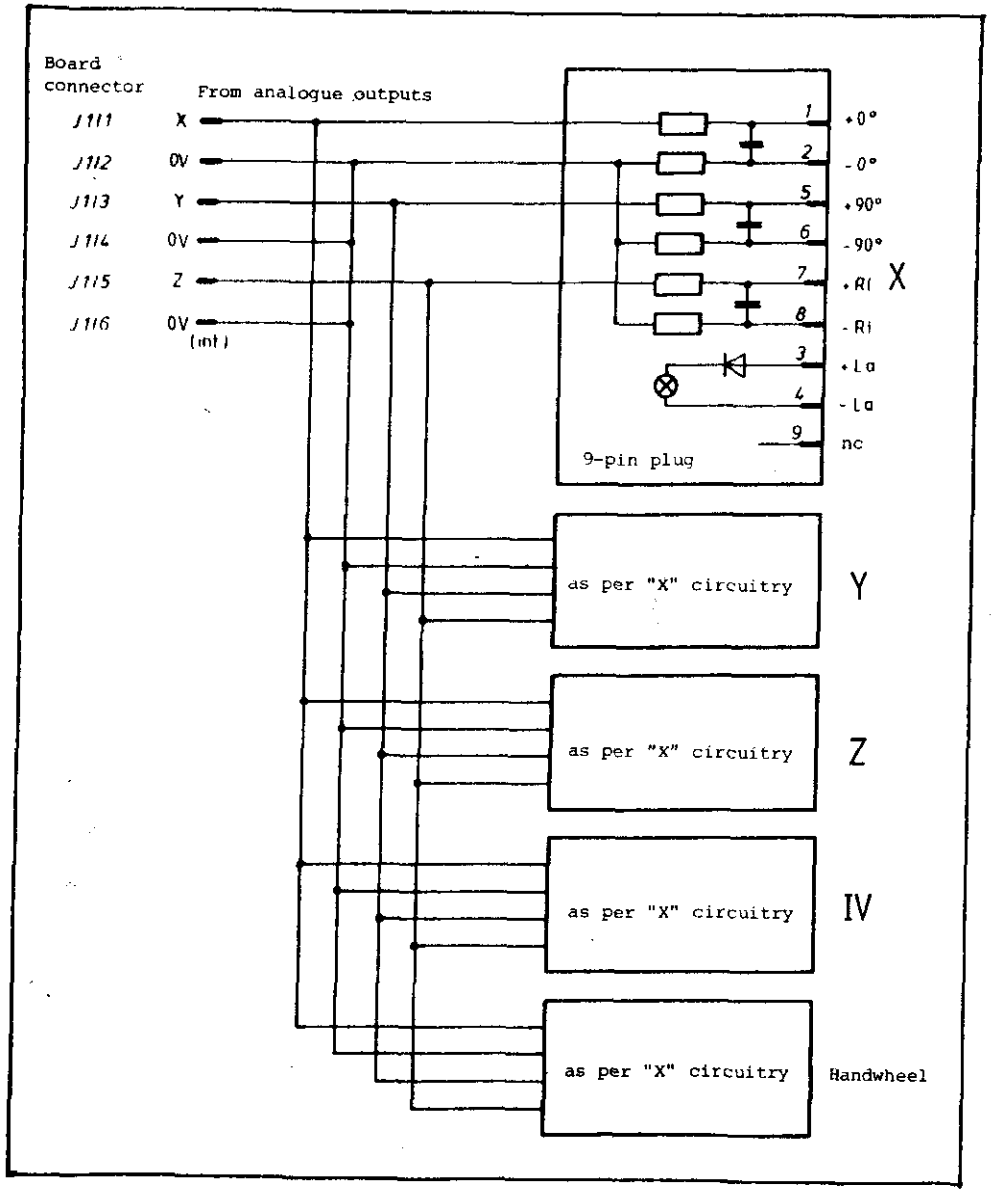
Control Type	Control Id. No.	NC Software issue	Test dialogue	Test Prog. Id. No.
TNC 150 **Q/W**	225 013 99	from... ...01	D	227 878 ZY
"	225 013 99	from... ...01	GB	227 880 ZY



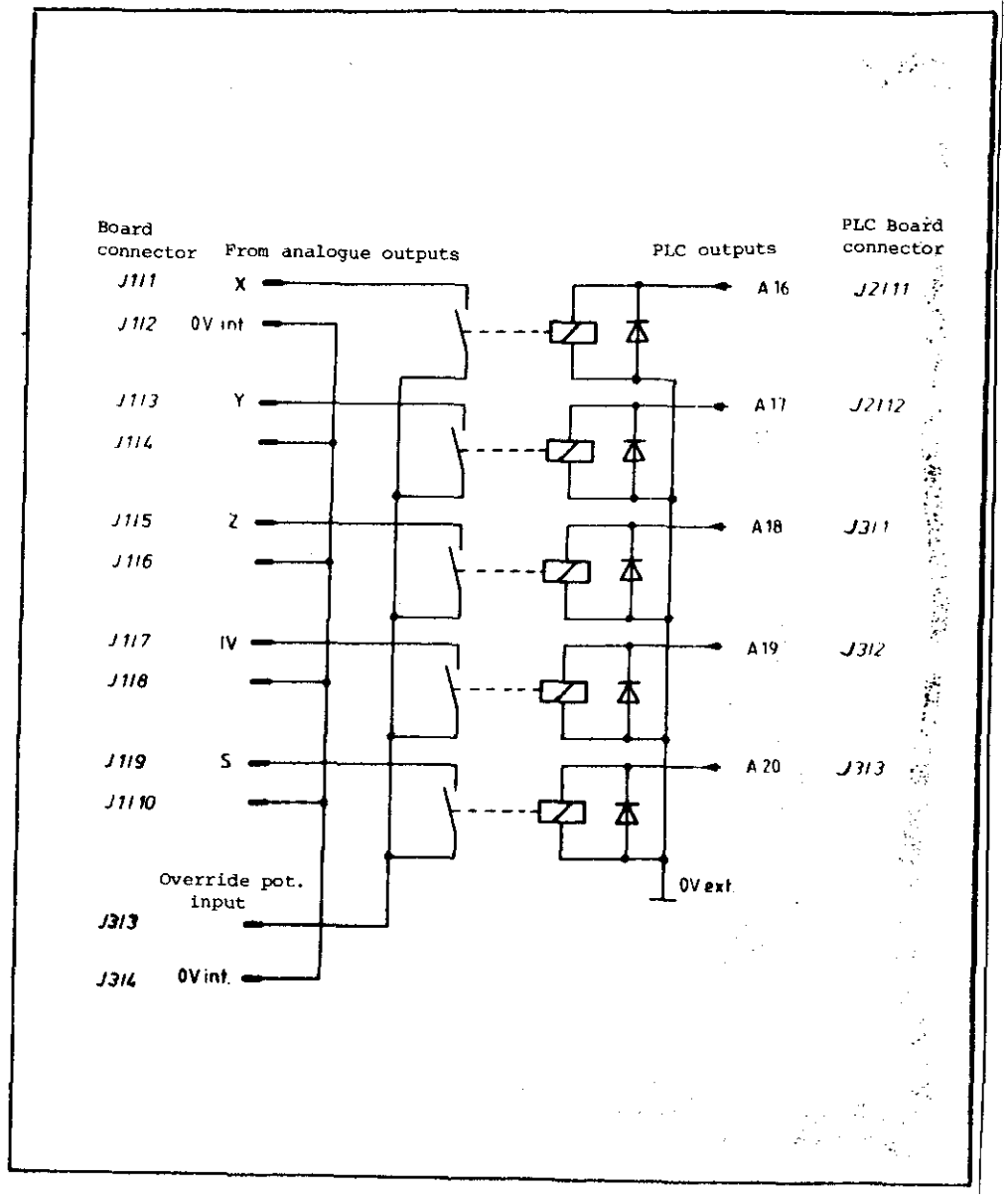
Diag. 1 Schematic: BURN-IN PC-Adapter (without bipolar outputs)



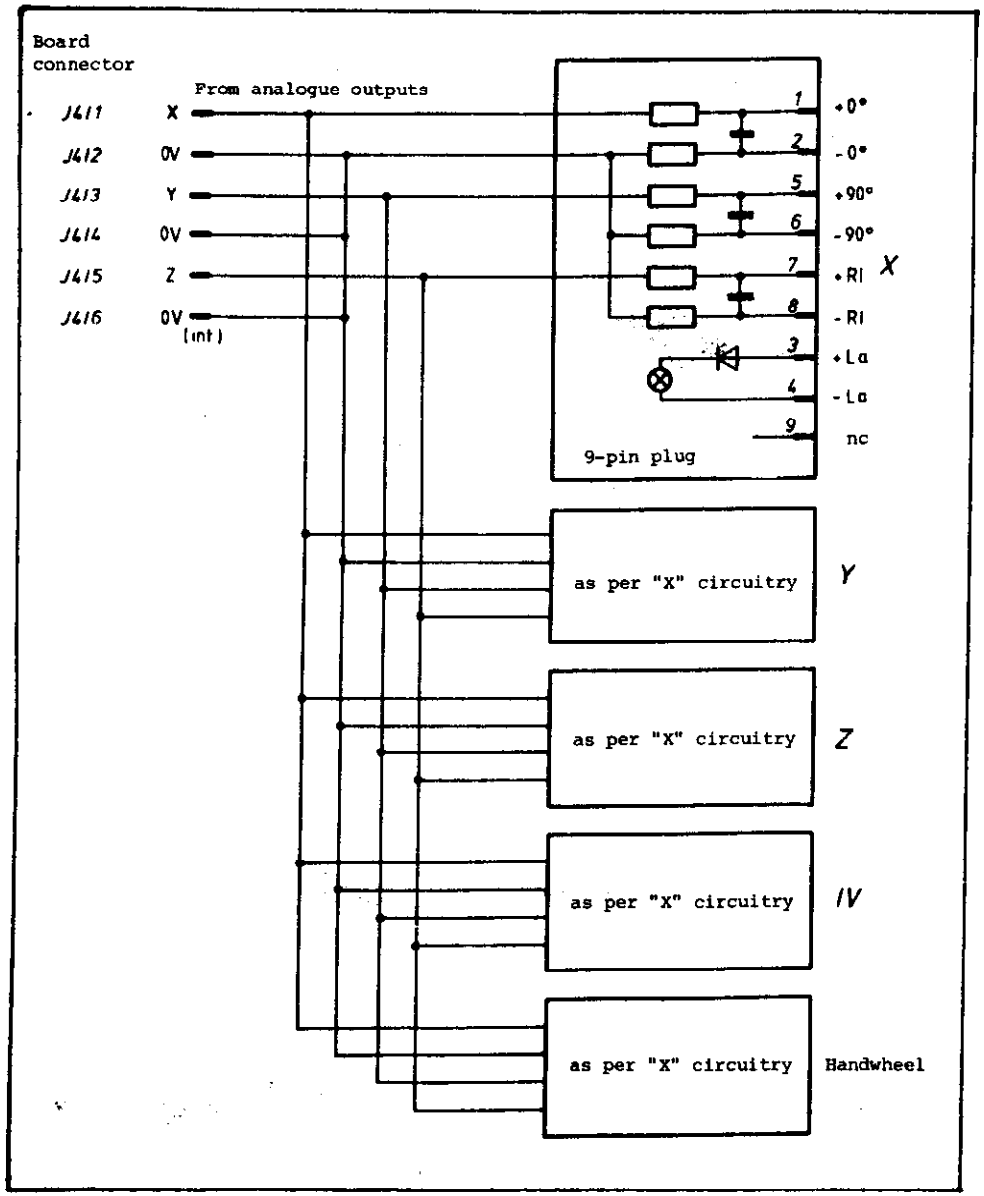
Diag. 2 Schematic: BURN-IN PC-Adapter (with bipolar outputs)



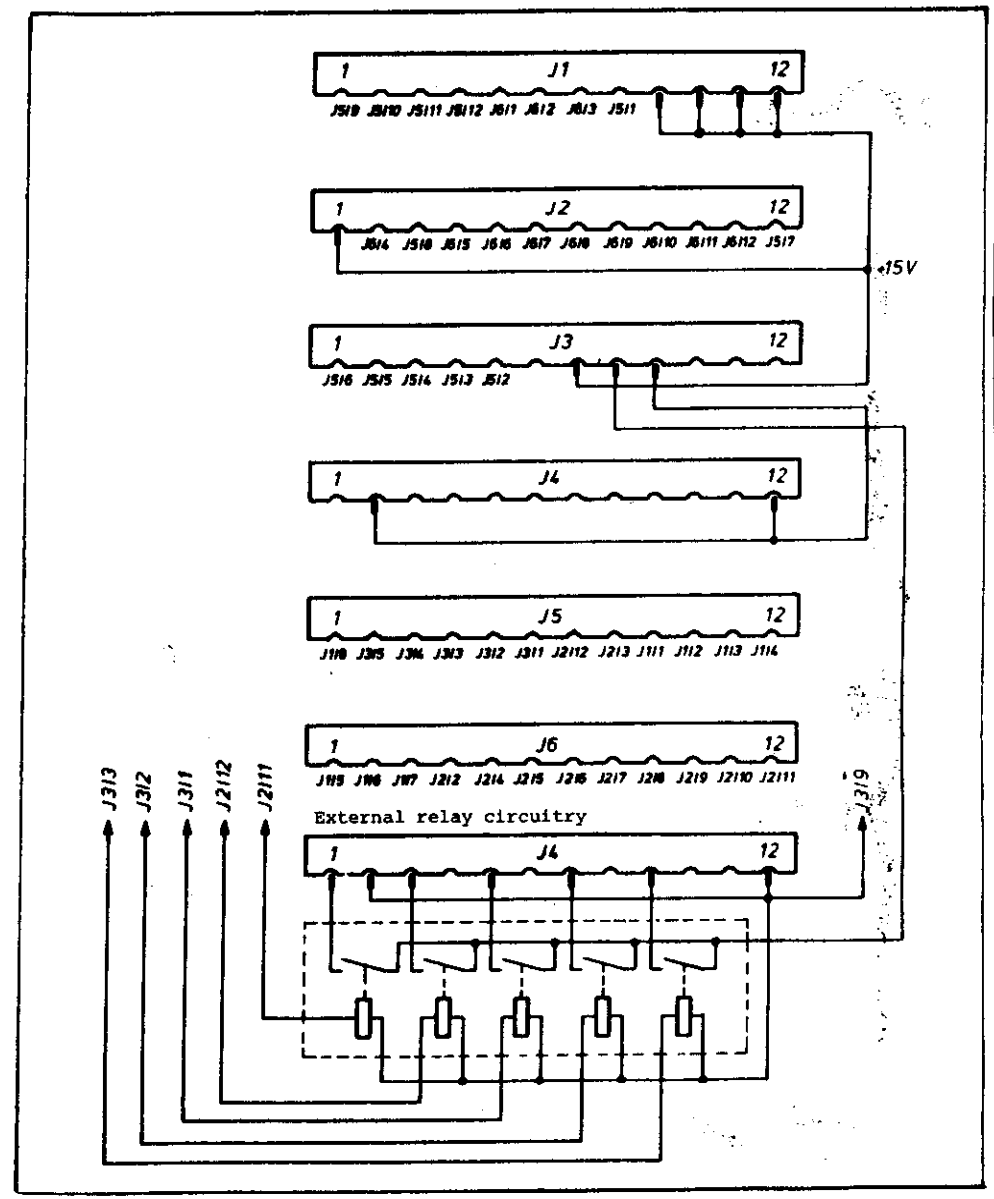
Diag. 3 Schematic: BURN-IN Adapter TNC 150 P



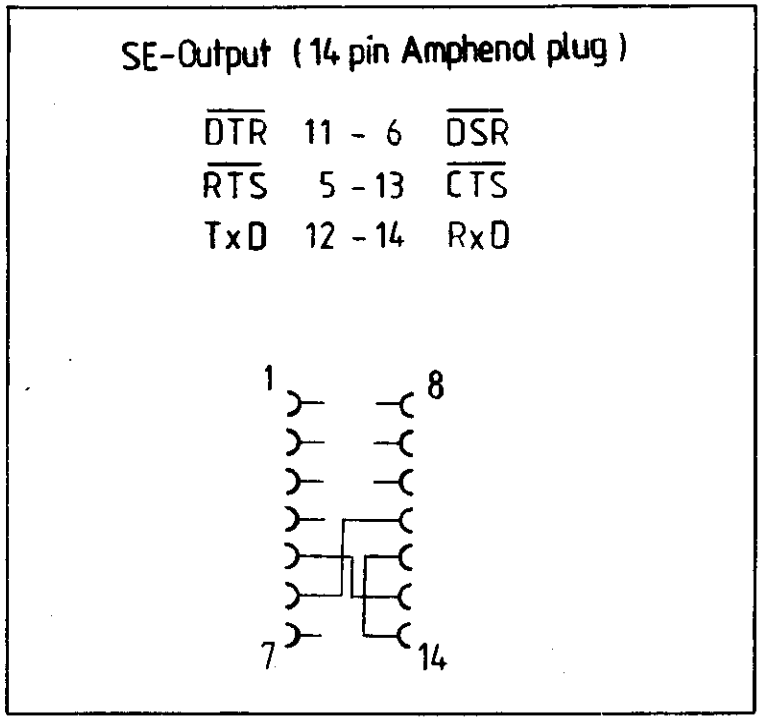
Diag. 4 Schematic: BURN-IN Adapter TNC 150 P



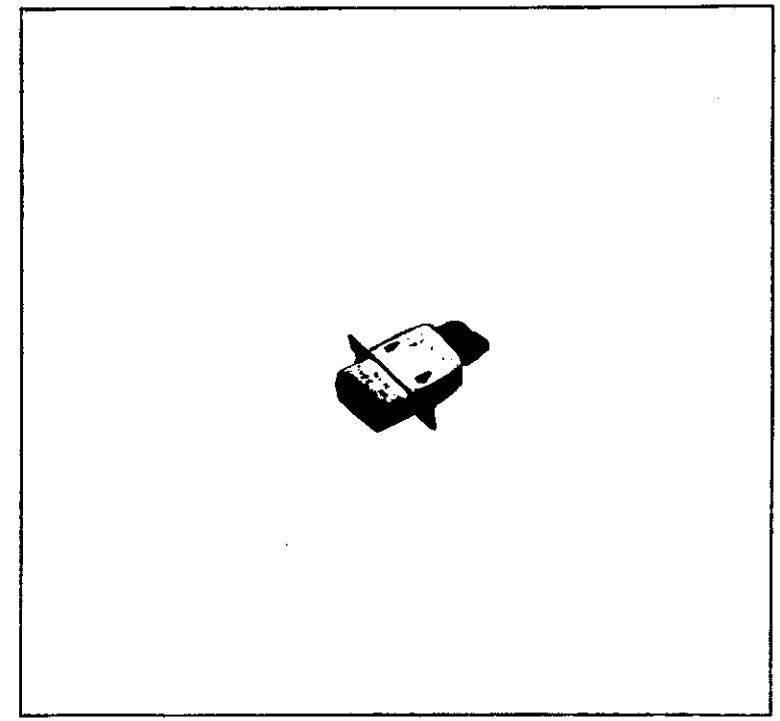
Diag. 5 Schematic: BURN-IN Adapter TNC 150 A



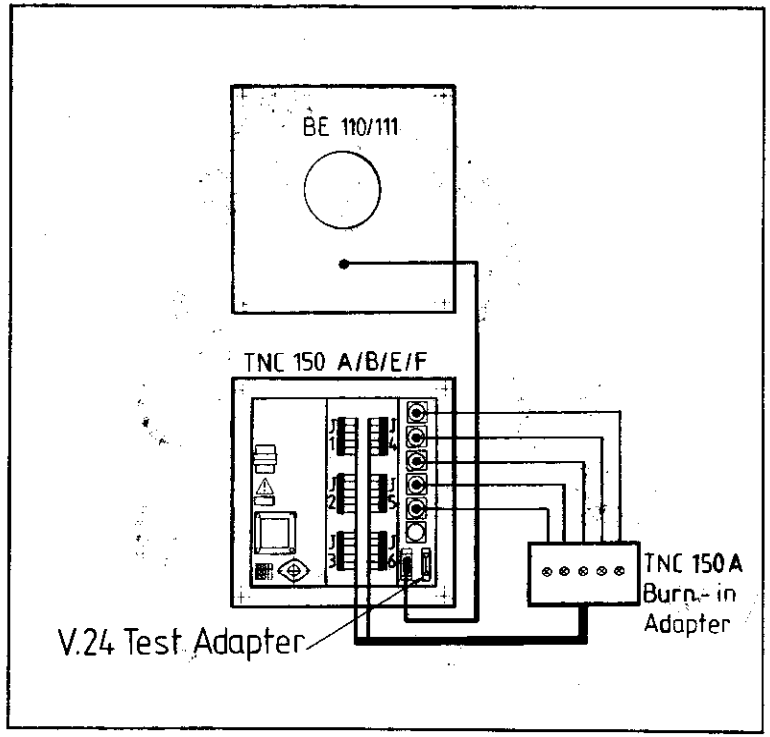
Diag. 6 Schematic: BURN-IN Adapter TNC 150 A



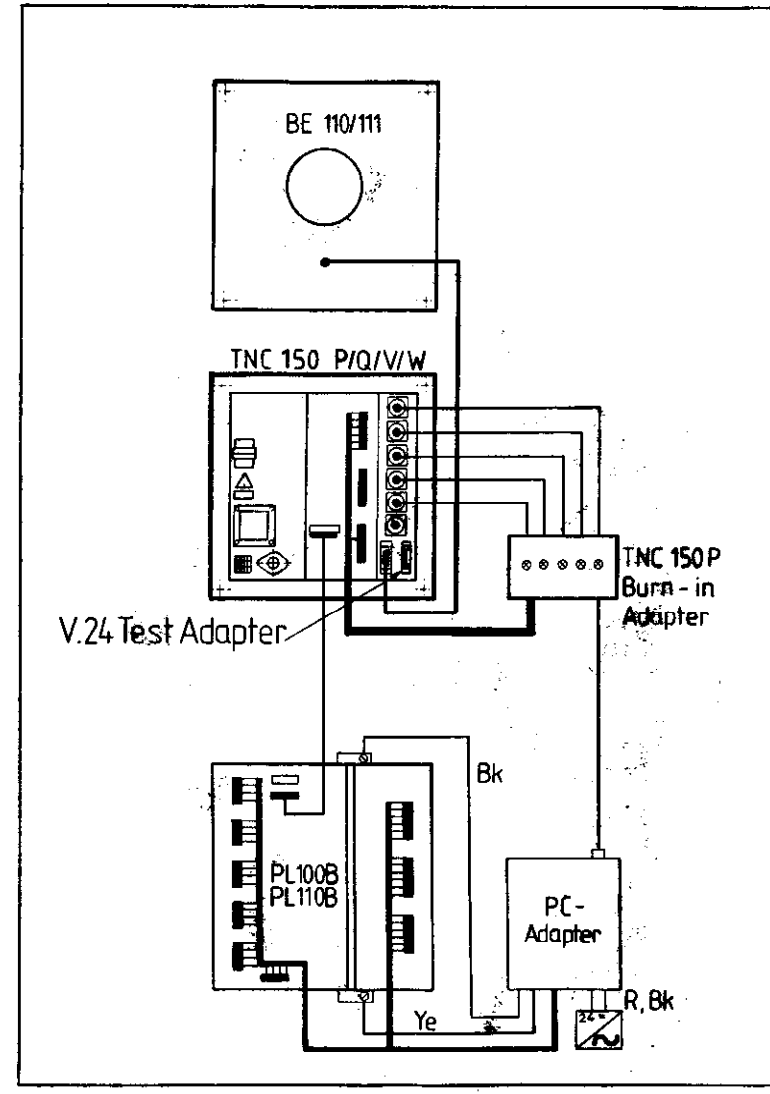
Diag. 7 V.24 connector (external data input and output port)



Diag. 8 V.24 Test Adapter



Diag 9: BURN-IN Adapter connections for TNC 150 A/B/E/F



Diag. 10: BURN-IN Adapter connections for TNC 150 P/Q/V/W

BURN-IN Test Program for the complete Control

1. Connections
   Depending on the type of Control, connect the test-adapters according to diagram 9/10, (page 25), except for the connection to the V.24 interface.

2. Loading the Test Program
   Connect the ME 101 C/ME 102 C to the V.24 interface of the Control, insert the program cassette and switch on the mains. If the dialogue "MACHINE PARAMETERS ERASED" is displayed on the VDU, the machine parameters have to be re-entered.

   The table below indicates the sequence of operations necessary to enter the Test Program into memory:

INSTRUCTIONS	VDU DISPLAY
Press the following keys on ME	POWER INTERRUPTION
Press the following keys on TNC	POWER INTERRUPTION
MOD	CHANGE MM/INCH
	POWER INTERRUPTION
	CODE NUMBER
6 2 0 1 5 9	POWER INTERRUPTION EXTERNAL DATA INPUT

   When the Test Program has been written into the RAM the data is checked using the checksum technique. If a fault is detected, axis LEDs X,Y,Z,IV will flash, and the following dialogue will be displayed:

   RE-ENTER PROGRAM XXXX
   CHECK SUM ERROR

   If no errors are detected, the question

   KEYBOARD TEST?

   will appear, and all the LEDs will be extinguished. Now remove the ME 101 C/ME 102 C and connect the V.24 Test Adapter (Diag.8) in its place.

3. Keypad Test
   The keypad is tested by pressing the individual keys of each set of keys in a certain sequence (top right set of 20 keys, top left set of 25 keys, bottom right set of 10 keys) beginning in each case with the top left key of each field. For each correct depression of a key, a "*" will be displayed on the VDU and the next LED will illuminate.

   In the case of a faulty key-code or an incorrect keying sequence, "KEYBOARD FAILURE" will be displayed, and the test will restart after about 1 sec. If several wrong keys are pressed in quick succession the error message and cycle restart will occur once for each incorrect key-push.

   After an error-free keypad test the BURN-IN time is reset and the stored error condition is cleared. At the same time, the following dialogue is displayed:

   KEYBOARD IN ORDER
   0, 1 OR 2 PC BOARDS?

   The number of PLC I/O Boards in use is then entered by pressing the appropriate key: 0,1 or 2. If no PLC I/O Boards are connected the test of the external potentiometer inputs will be skipped (cf 5i).

4. Adjustement of Spindle and Override RPM Pots
   Set the internal pots to 100%. If the VDU is not connected, the LED rows MOD P I and are used to indicate when the Override pot. and Spindle pot. respectively are adjusted to 100%.

5. Cyclic Tests
Each test can be selected via the keyboard. If no fault arises, the tests run in the following sequence. With each new test a different LED will illuminate.

a) Key [0]
Test internal pots and battery voltage
The adjustment of the pots is correct at 100 ± 2%

b) Key [1]
EPROM test for Main Processor Board
The contents of the EPROMs are tested by the generation of checksums. The checksum for each addressing range is displayed in the form of a data word; the MSB giving the sum actually generated, the LSB giving the expected value. The address range displayed refers to the first checksum that differs from the expected value.

c) Key [2]
RAM test for Main Processor Board
Range: EØØØH to FFF9H
excluding working space: FØØØH to FØ1FH

d) Key [3]
RAM test for Memory Board
Range: FFFFFH to FØØØØH

e) Key [4]
RAM test for PLC
Range: EØØØH to FFFEH, addressed via CPU

f) Key [5]
Static RAM test for CLP Prcessor board
Range: DØØØH to FFFFH

g) Key [6]
Test PLC instruction decoder and accumulator flip-flop

h) Key [7]
Test I/O ports and monostable periods
(Main Processor: 20ms)
(CLP Processor: 5ms)

i) Key [8]
Test ext. pot. inputs, analogue outputs, and outputs A16 - A20.
Five external relays, driven from outputs A16 - A20, are used to connect analogue outputs X,Y,Z,IV,S respectively to the ext. pot. input (see diag. 4/6, page 22/23). The test is made at three different voltages:
200mV, 5V, 9,5V

j) Key [9]
Test V.24 interface

k) Key [X]
Test supervision circuit

l) Key [Y]
Test reference-pulse input, start/stop flip-flop

m) Key [Z]
Test transducer/EXE inputs

6. Fault Recognition
If a fault occurs, it will be displayed on the VDU. The test cycle will be interrupted and the BURN-IN Time stops. In the event of a fault in either the override pot. or the spindle pot., the LED row or P I respectively will be flashed. In the event of a fault in the sense circuit for the battery voltage, the LEDs and will be flashed. In all other cases, all LEDs will be flashed.
Each test can be restarted by pressing the appropriate key. Any fault message will remain memorized and can be recalled by pressing the CL key, followed by the key. By means of the DEL key the fault message can be cleared and the test cycle restarted.
If the CLP Processor recognizes a fault during execution of the main program, the error message

CLP PROCESSOR FAULT: XXXX

will be displayed. The program can then only be restarted by switching the mains supply off and on again.

Possible Error Codes (XXXX):

Code	Meaning
ØØØ8	Incorrect OP-code
ØØØA	Incorrect command
ØØØB	Incorrect display mode
ØØØD	Operating temp. too high
2ØXX	EPROM CRC-sum error
21XX	RAM CRC-sum error

7. Stopping the Program, Returning to the Control Program.
If the key is pressed, the dialogue PRESS NOENT KEY will be displayed following the memory test. If this message is then acknowledged with the key, the BURN-IN Test will start again from the beginning. Alternatively, if it is acknowledged with the key, the Test Program will be erased and the dialogue POWER INTERRUPTED will be displayed on the VDU.

8. Restart Keyboard Test
The keyboard test can be restarted by pressing the key. Further procedure as per point 3.

9. Restart with "0,1 or 2 Boards" Request
By pressing the key, the request for the number of PLC boards will be displayed. Further procedure as per point 3.

10. Adjustment of Override and Spindle Pots.
The nulling routine can be initiated with the key. Further procedure as per point 4.

11. Interruption of the BURN-IN Test.
The tests can be interrupted at any time by turning off the mains supply. This, however, does not apply to the Memory Board RAM tests.

The test run will start from the beginning when the mains is switched on and the key is pressed, provided that no error message is stored. If a keyboard test has not been completed before an interruption to the mains supply, the keyboard test will be executed first of all, when power is restored.

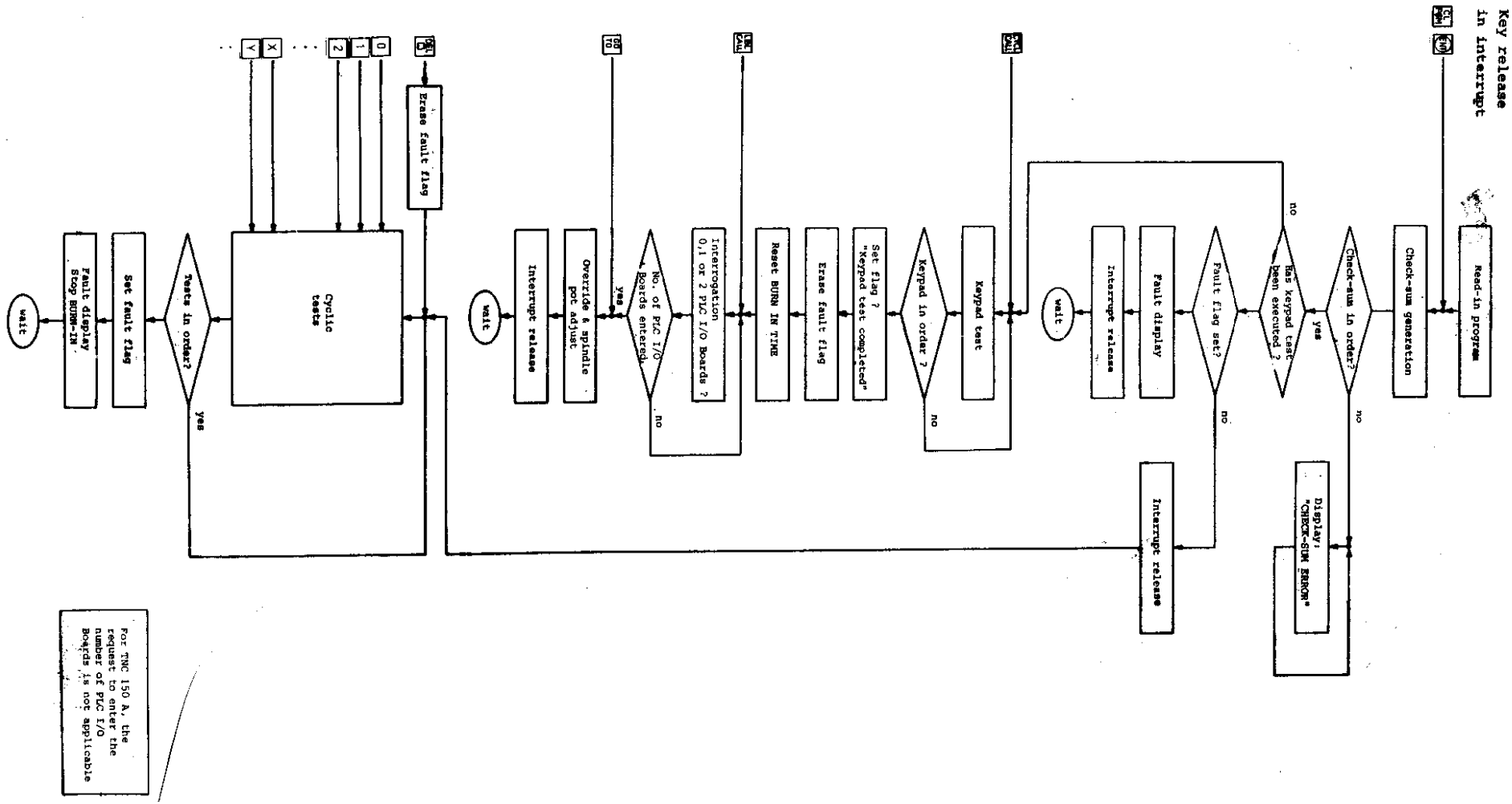
Neither BURN-IN Time nor an error message is lost as a result of an interruption to the mains supply. If the following message is displayed on the VDU:

RE-ENTER PROGRAM XXXX
CHECK SUM ERROR

and the LEDs of the axis keys X,Y,Z,IV are flashing, then a mains interruption has occurred during the Memory Board RAM test, and the Test Program must be re-entered.

12. Operation without VDU
After completion of the keyboard test, the mains can be switched off and the VDU disconnected. The restarting of the test program is as per point 11.

13. Block Diagram of the BURN-IN Test Program



Description of the Test Program TNC 150

The Test Program TNC 150 is an extension of the BURN-IN Test Program, and provides the following additional functions:

1. Individual Test Run

   Key [CE DEF]
   This allows any of the tests contained within the BURN-IN Test Program to be run repetitively. The following dialogue will appear on the VDU:

   "INDIVIDUAL TEST RUN"
   ERROR INTERRUPT: KEY [0]
   NO ERROR INTERRUPT: KEY [1]

   This means that if the [0] key is pressed prior to selecting a test, that test will run repetitively until an error occurs. Upon detecting an error, the test will stop and an error indication will be given.
   If instead, the [1] key is pressed, the occurrence of an error with cause the test to stop. There will be no error indication. This mode permits cyclic measurements.

   Furthermore, in the "ERROR INTERRUPT" mode, the faulty address on the Main Processor Board or the Memory Board can be written to with either AAAA (1010 1010 etc) or 5555 (0101 0101 etc).

   The following dialogue will be displayed:
   ERROR AT ADDRESS: XXXX
   WRITE TO FAULTY ADDRESS
   WITH AAAA: KEY [0]
   WITH 5555: KEY [1]

   If key [0] is pressed, the dialogue response will be:
   WRITE READ
   AAAA XXXX

   If key [1] is pressed, the dialogue response will be:
   WRITE READ
   5555 XXXX

   A repetitive test can be aborted using the [CE] key. The test will then be run once again in sequence, as per the BURN-IN Tests.

2. VDU Test

   Key [2]
   This key permits the entire character set to be displayed, character by character, over the whole of the screen.
   This can be started and stopped using the [+/-] key.

3. Output of +10V at the DAC and Analogue Outputs.

   Key [3]
   The polarity of the output voltage can be changed with the [+/-] key.

4. Offset Adjustment of the DAC and Analogue Outputs

   Key [PGM NR]
   Adjust for positive and negative polarity symmetry between 16mV and 18mV. the polarity can be reversed with the [+/-] key.

5. Board Exchange

   As an aid in board replacement, each error message is accompanied with a reference to the likely defective board. Where a fault symptom cannot be related to just one board, more extensive dialogue is displayed.

3. Exchange Information

Note: All inputs/outputs from the TNC 150 Control can only be connected to circuits which have voltages conforming to VDE S.73 §8.

Do not disconnect or connect plugs under power!

NC machines also need protection and installation safety as required for manually operated machines (e.g. EMERGENCY STOP). Their function should be checked during commissioning of the machine and of a new Control

Before exchanging a Control the machine parameters should be noted or stored on magnetic tape.

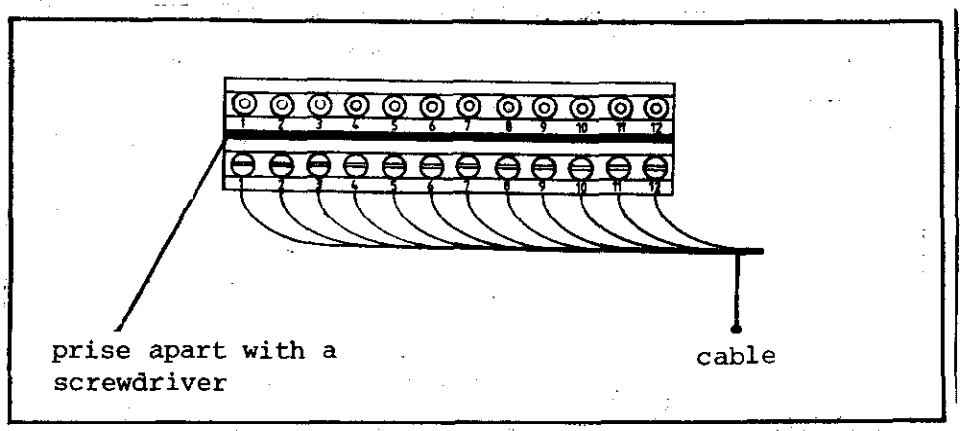
DR. JOHANNES HEIDENHAIN
D-8225 Traunreut
Telefon (08669) 31-0, Telex 56831

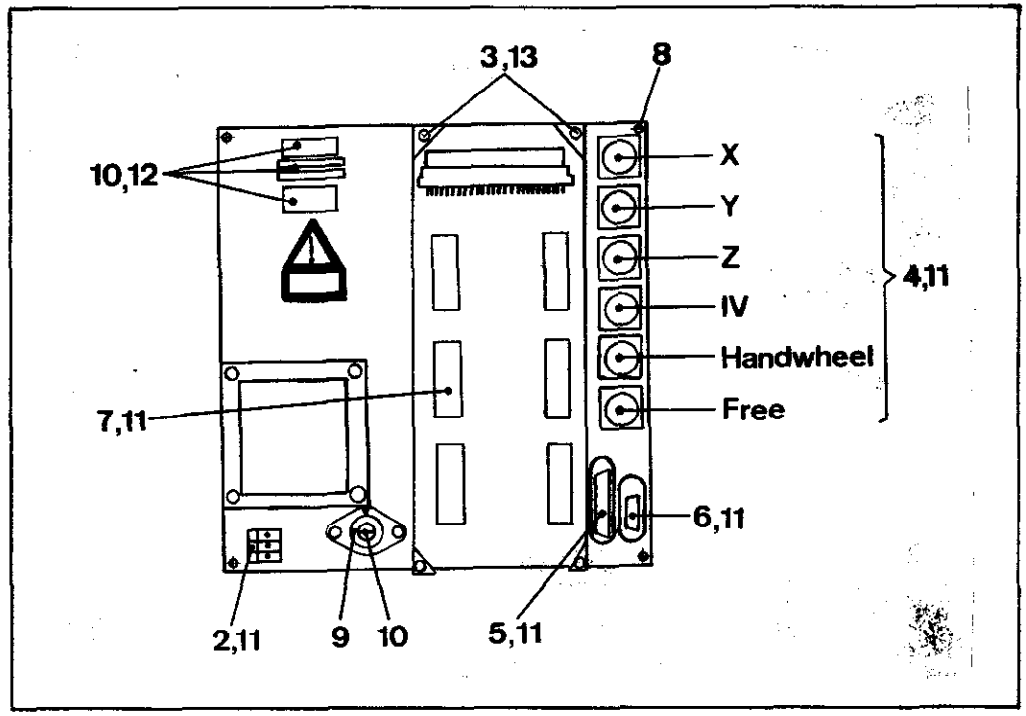
Kundendienst

3.1 Exchanging Control Units

3.1.1 Procedure for exchanging the TNC 150 A/B/E/F Control.

1. Gain access to the rear of the Control.
2. Remove the mains supply.
3. Remove the connector box cover-plate from the rear of the Control.
4. Mark the measuring system plugs (X,Y,Z,IV, Electronic Handwheel) and remove them.
5. Disconnect the VDU from the Control.
6. Disconnect any external data devices.
7. Disconnect connector strips J1-J6, using a screwdriver to prise the connectors apart (Do not unscrew individual wires).

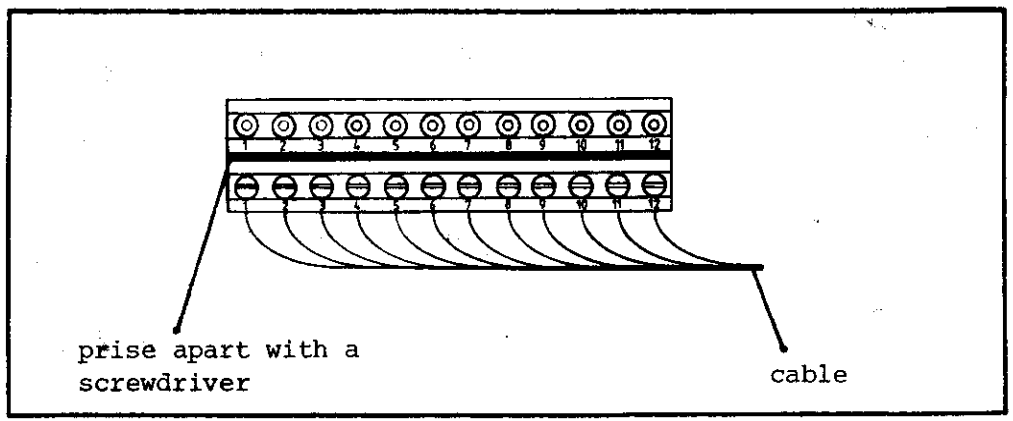


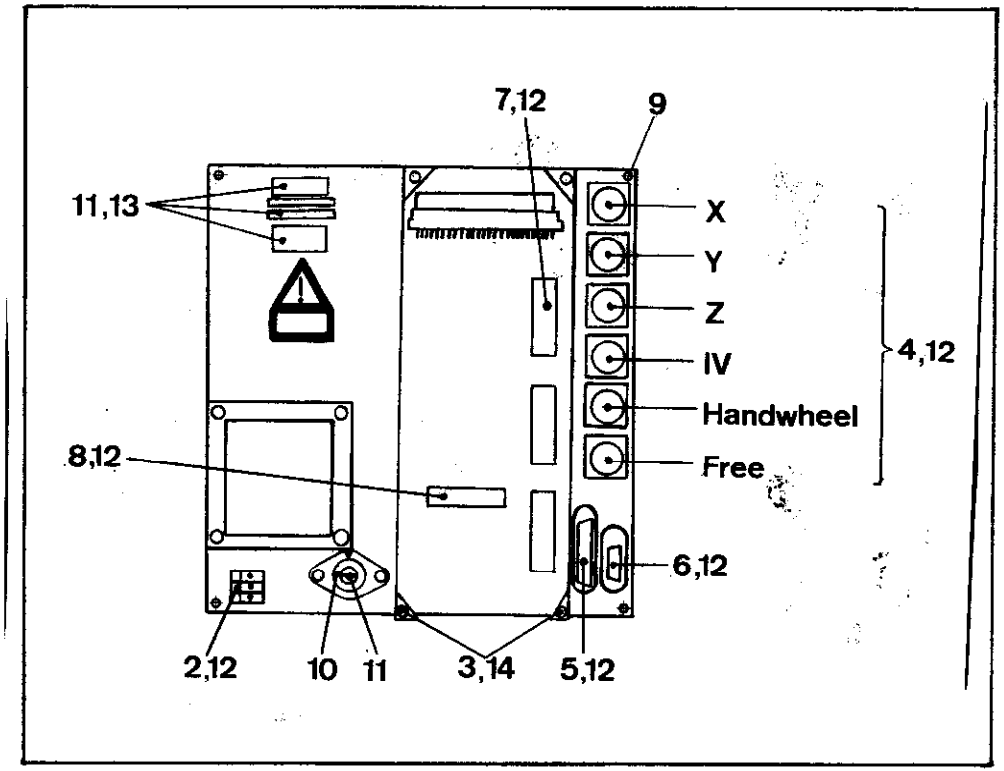


8. Remove the faulty Control, removing the fixing screws if not already removed in 1.
9. Install the new Control - check the voltage selector position.
10. Check the fuse-rating (see type-plate).
11. Reconnect all cables previously removed.
12. Obtain from the type-plate the Control's Id. No., NC and PLC Software Nos., and write them in the machine handbook.
13. Refit the connector box cover-plate.
14. Turn on the mains voltage.
15. Reprogram the machine parameters.
16. TNC is now ready to use.

3.1.2 Procedure for exchanging the TNC 150 P/Q/V/W Control

1. Gain access to the rear of the Control.
2. Remove the mains supply.
3. Remove the connector box cover-plate from the rear of the Control.
4. Mark the measuring system plugs (X,Y,Z,IV, Electronic Handwheel) and remove them.
5. Disconnect the VDU from the Control.
6. Disconnect any external data devices.
7. Disconnect connector strips J1-J6, using a screwdriver to prise the connectors apart (Do not unscrew individual wires).
8. Remove the connecting cable to the PL 100 B/110 B from the Control.

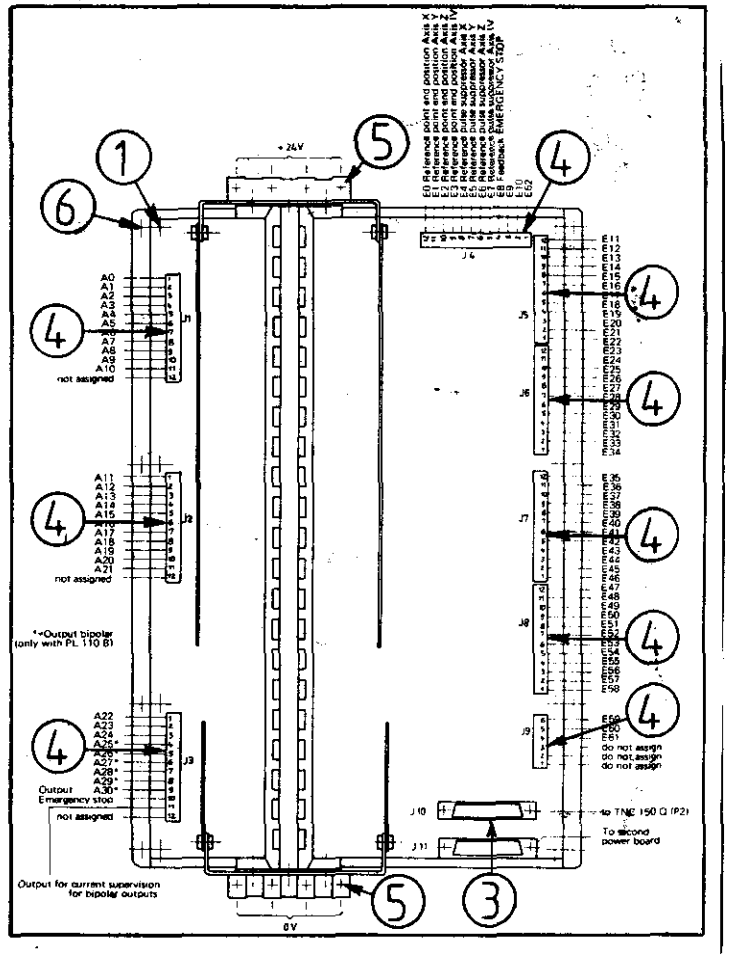




9. Remove the faulty Control, removing the fixing screws if not already removed in 1.
10. Install the new Control - check the voltage-selector position.
11. Check the fuse-rating (see type-plate).
12. Reconnect all cables previously removed.
13. Obtain from the type-plate the Control's Id. No., NC and PLC Software Nos., and write them in the machine handbook.
14. Refit the connector box cover-plate.
15. Turn on the mains voltage.
16. Reprogram the machine parameters.
17. TNC is now ready to use.

3.1.3 Procedure for exchanging the PLC I/O Board of the PL 100 B/110

1. Remove the fixing screws of the heatsink cover-plate.
2. Remove the heatsink cover-plate.
3. Disconnect the TNC 150 connecting cable.
4. Disconnect connector strips J1-J9, using a screw driver to prise the connectors apart.
   (Do not unscrew individual wires)
5. Remove the voltage supply (+24V and OV)
6. Remove the fixing screws of the PL 100 B/110 B unit.
7. Install the new unit following the above procedure in reverse order.



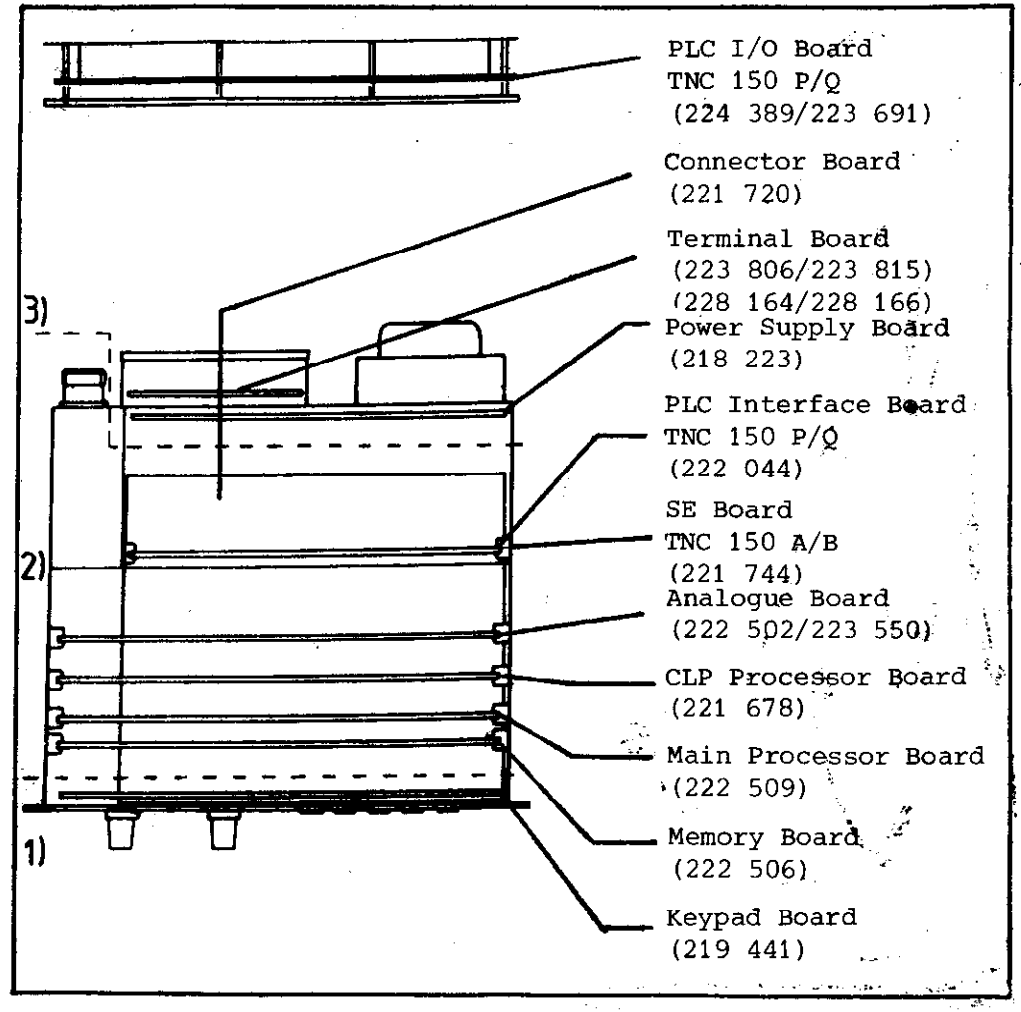
3.2 Board Exchange

Board Arrangement

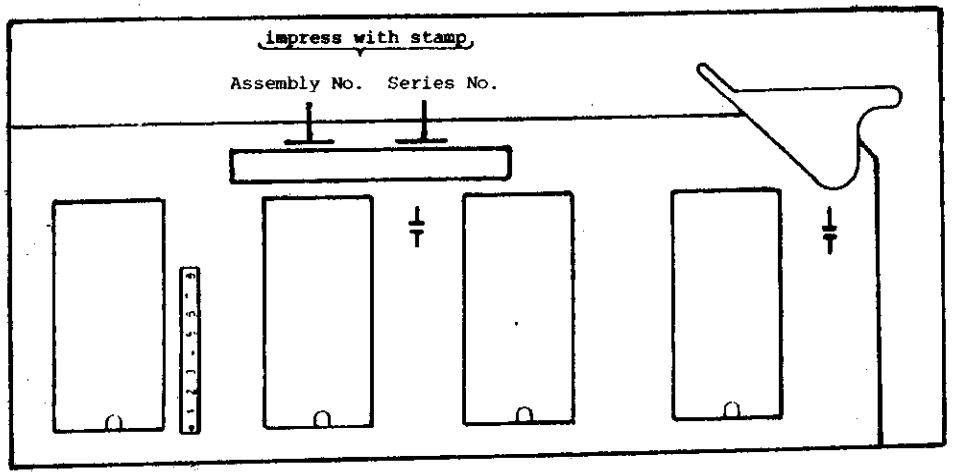
The TNC 150 consists of three main sections:

1) The frontplate/Keypad Board assembly;
2) The housing/Connector Board assembly, with five plug-in boards, namely:
   .Memory Board
   .Main Processor Board
   .CLP Processor Board
   .Analogue Board
   .either SE Board TNC 150 A/B/E/F
   or PLC Interface Board TNC 150 P/Q/V/W
3) The backplate, Power Supply Unit and Terminal Board assembly.

Board arrangement TNC 150 A/AR/B/BR
TNC 150 P/PR/Q/QR



Caution: .Please observe MOS protection measures when exchanging boards.
.Only exchange boards which have identical assembly numbers. The assembly number is impressed on every board, to the left of the serial number.



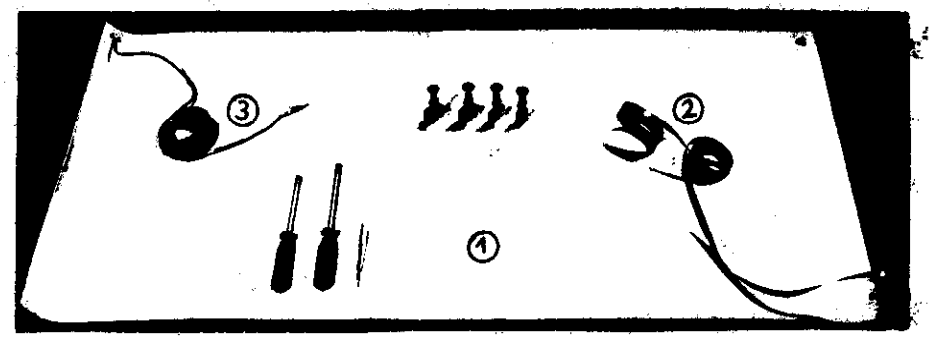
Work area requirements
The TNC 150 contains sub-assemblies with MOS elements. Although MOS ICs are equipped with an input protection diode network, to eliminate the build-up of static charges care must be taken when handling these elements.
The following requirements in the work area must be met: Prior to working with MOS components or with assemblies containing MOS elements, all table coverings, instruments, tools, and work personnel must be properly grounded.

A portable "MOS-HANDLING-SET" for field service is necessary when exchanging the operating software and/or servicing the TNC 150:

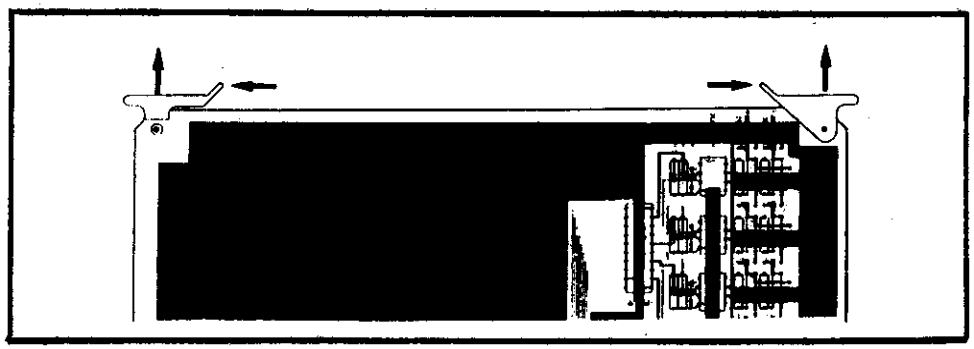
1 a conductive work surface

2 a wristband that provides an electrical connection between person and conductive work surface

3 a cable that equalizes potential differences between conductive work surface and ground



Exchanging the pluggable boards
Unscrew the 5 mounting screws and remove the housing cover.
Removing the boards:
Press the board ejector keys outwards and pull out the individual board form the top.

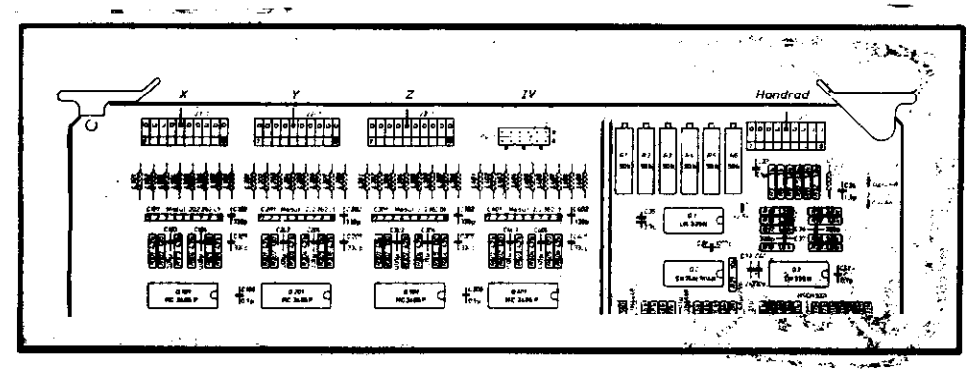


Inserting the boards:
The connectors of the boards are coded: incorrect insertion is therefore avoided. Press the board firmly into the Connector Board using the ejector keys tilted inwards.

Main Processor and CLP Processor Board:
When exchanging these boards insert program EPROM's IC-P1 to IC-P3 on the CLP Processor Board and IC-P4 to IC-P10 on the Main Processor Board.

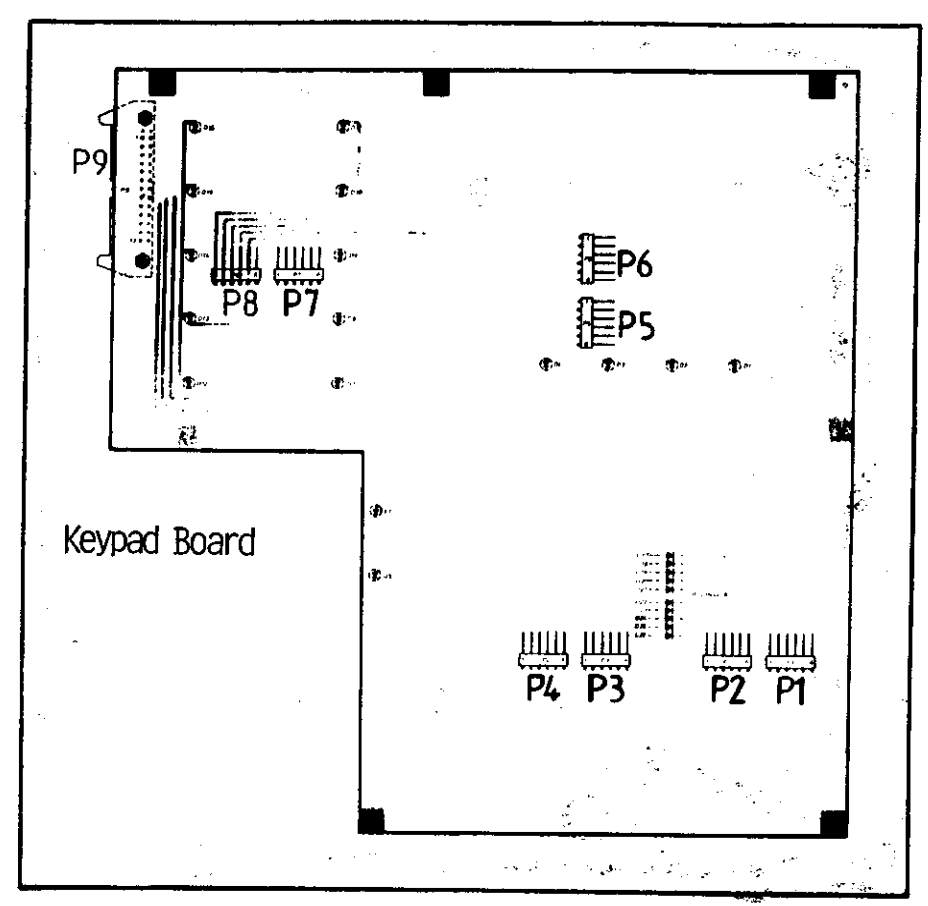
Memory Board:
During the exchange or removal of the Memory Board the buffered RAM will no longer be supplied with voltage, which means that the machine parameters and any user-programs will be lost!
Before inserting the new Memory Board, plug in the relevant EPROMs, (IC-P11 to IC-P14 in the case of TNC 150 A/E/P/V; IC-P11 to IC-P16 in the case of TNC 150 B/F/Q/W), paying particular attention to their correct location and orientation.

Analogue Board
Before removing the Analogue/Analogue TTL Board pull off and mark the connector plugs for the measuring system inputs/ square wave signal inputs and the electronic handwheel input. The connector sockets on the board are coded with coding pins.



Exchanging the Keypad Board:

.Remove the 6 cross-head fixing screws from the frontplate.
.Tilt the frontplate outwards.
.Remove connectors J13 (feedrate-override potentiometer) and J14 (spindle-override potentiometer) from the Connector Board.
.Remove the ribbon cable connector P9 from the Keypad Board.
.Remove the 7 cross-head fixing screws which secure the Keypad Board to the frontplate.
.Pull off the keypad connectors, P1 to P8 from the Keypad Board.
.Remove the Keypad Board.



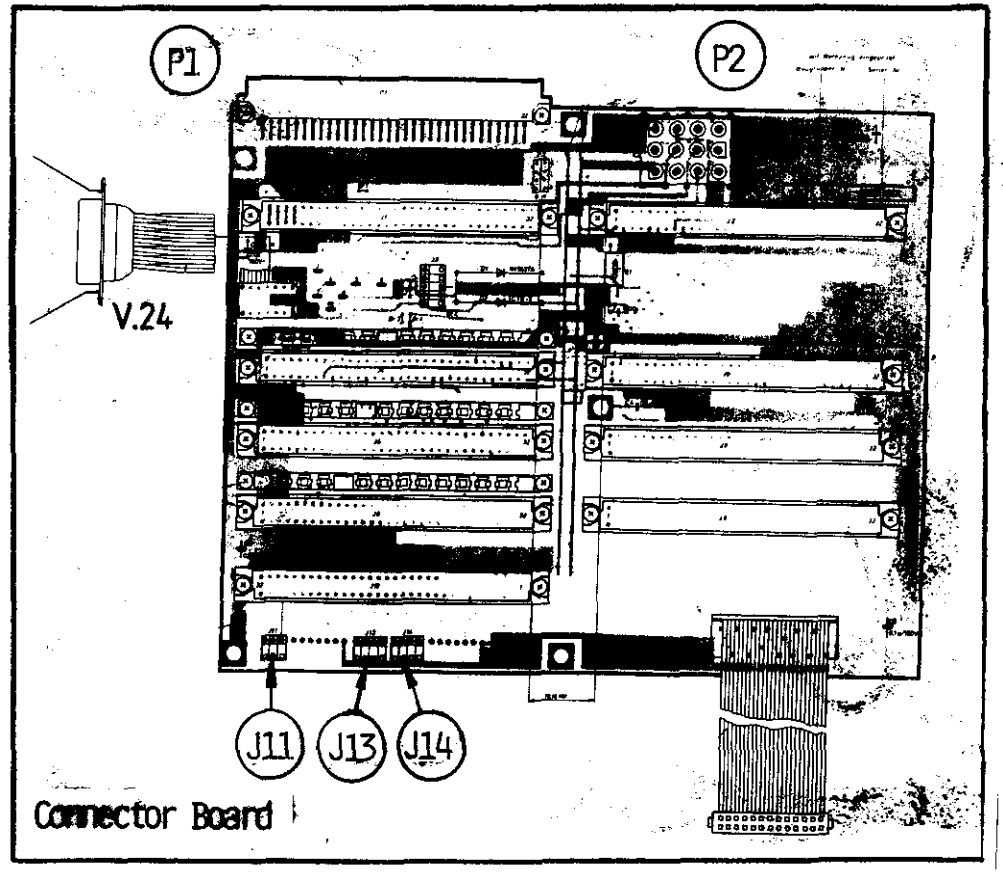
When rebuilding the assembly, ensure that the keypad connectors are firmly engaged in their respective sockets, and that the LEDs project through the corresponding bored holes in the keypad housing.

Exchanging the Power Supply Unit:

.Remove the 4 cross-head mounting screws from the rear of the Control (2 screws are found in the connector box).
.Remove the backplate with the Power Supply Unit and Terminal Board.
.Disconnect the ribbon cable connector, P1, from the Connector Board (see diagram).
.Remove the voltage supply plug, P2, from the Connector Board (see diagram).

Exchanging the Connector Board:

.Remove the 7 cross-head fixing screws.
.Disconnect the battery connections (J11).
.Remove the 2 cross-head fixing screws of the V.24 connector on the rear of the Control.
.Push the V.24 socket through its recess in the Control housing.
.Unsolder the connectors to the VDU socket from the Connector Board (solder terminals 1 to 12). Note the colour of the wire connected to each terminal.
.Pull the Connector Board from the front of the Control housing.



3.3 Software Exchange

General

The TNC 150 operating software is stored in 13, 14 or 16 EPROMS, of type D2764, depending on the software issue.

TNC 150 **A/E/P/V:**
- IC-P1...IC-P3 (CLP Processor board)
- IC-P4...IC-P10 (Main Processor board)
- IC-P11..IC-P13 (Memory board) or
- IC-P11..IC-P14 (Memory board, from software issue ... ... 05)

TNC 150 **B/F/Q/W**
- IC-P11..IC-P16 (Memory Board, with "B" software)

Every operating software is specified with an 8 digit Software No.

example: 221 804 01 complete software Id. No.
221 804 primary software Id. No.
01 update software index

Each of the 13, 14 or 16 programmed EPROMs (IC-P1...IC-P13/ IC-P14/IC-P16) is specified with an 8 digit Id. No.

example: 221 410 CA complete Id. No. of the progr. EPROM
221 410 primary Id. No. of the progr. EPROM
C position on the board
(C = IC-P12, HEXadecimal counting manner)
A update index

The operating software includes

o NC software (IC-P1...IC-P8, IC-P10...IC-P13/IC-P14/IC-P16)
o PLC software (IC-P9)

TNC 150 **A**: Control with o NC software and
o PLC standard software

TNC 150 **B**: Control with o "B" NC software and
o PLC standard software

TNC 150 **E**: as TNC 150 A, however with export NC software

TNC 150 **F**: as TNC 150 B, however with "F" export NC software

TNC 150 **P**: Control with o NC software and
o PLC standard software or
PLC custom software

TNC 150 **Q**: Control with o "B" NC software and
o PLC standard software or
PLC custom software

TNC 150 **V**: as TNC 150 P, however with export NC software

TNC 150 **W**: as TNC 150 Q, with "F" export NC software

The **dialogue language** of the TNC 150 **A/E/P/V** is determined by **IC-P4** (located on Main Processor Board), and **IC-P10** for the TNC 150 **B/F/Q/W**. Each has its own IC program number.

Following dialogues are available at this time

Software for TNC 150**A/E/P/V**:		Software for TNC 150**B/F/Q/W**:	
German	(D)	German	(D)
English	(GB)	English	(GB)
French	(F)	French	(F)
Italian	(I)	Italian	(I)
Spanish	(E)	Spanish	(E)
		Swedish	(S)
		Finnish	(SF)
		Dutch	(NL)
		Russian	(SU)

The Id. Nos. of the other programmed EPROMs are the same (for a given IC position) in all languages. (prerequisite: same software issue).

Exception: **IC-P9 (PLC software)**
The standard PLC program (EPROM position IC-P9) can be replaced with a custom PLC program for the TNC 150 **P/Q/V/W**.
(see chapter SOFTWARE: PLC Reference List)

The dot matrix for all VDU displayed characters is contained in **IC-P1 (character generator)**.

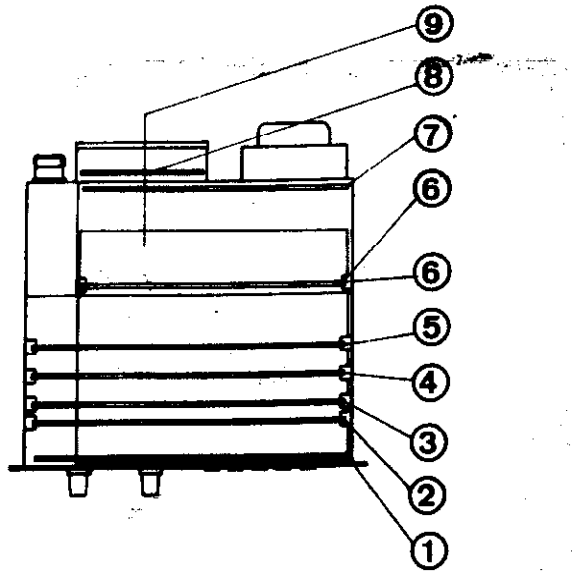
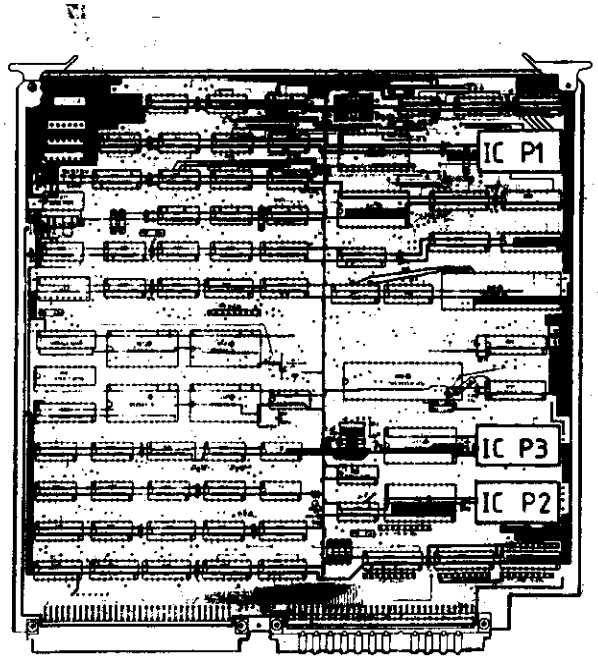
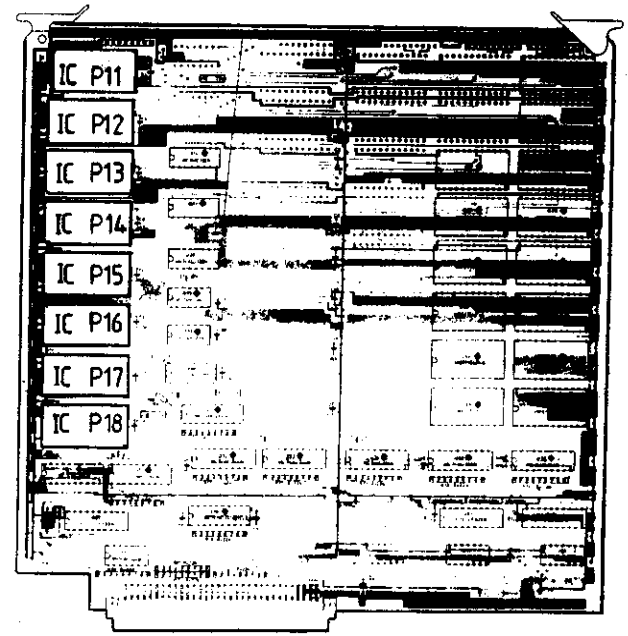


Illustration left: Arrangement of PCBs in the Control

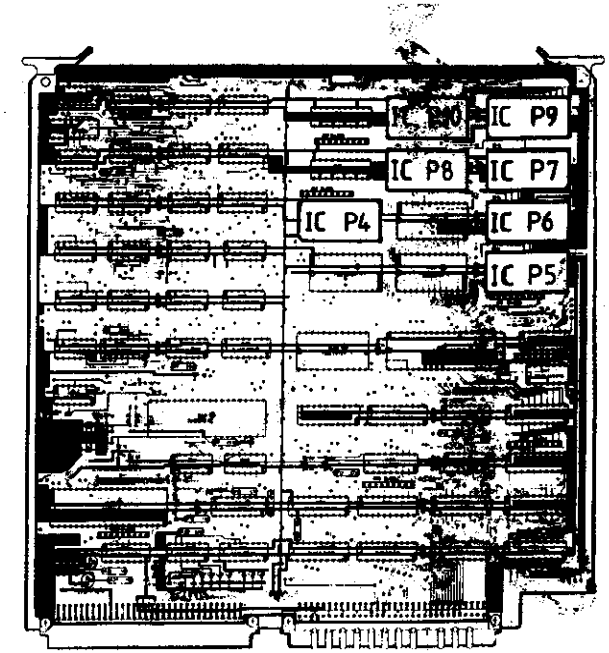
Illustration below: Arrangement of EPROMs on the various boards



CLP Processor Board
221 678 ..



Main Processor Board
222 509 ..



Memory Board
222 506 ..

Software Exchange

Caution: When exchanging the software observe the MOS protection procedures!

o The cover of the Control can be removed after unscrewing the 5 cross-head mounting screws (top side)

o To exchange the program, the following boards
- Memory Board 2
- Main Processor Board 3
- CLP Processor Board 4

have to be removed from the assembled Control

Thereto, lift the board ejector keys and press outwards, pull out board from above and lay onto MOS protection mat.

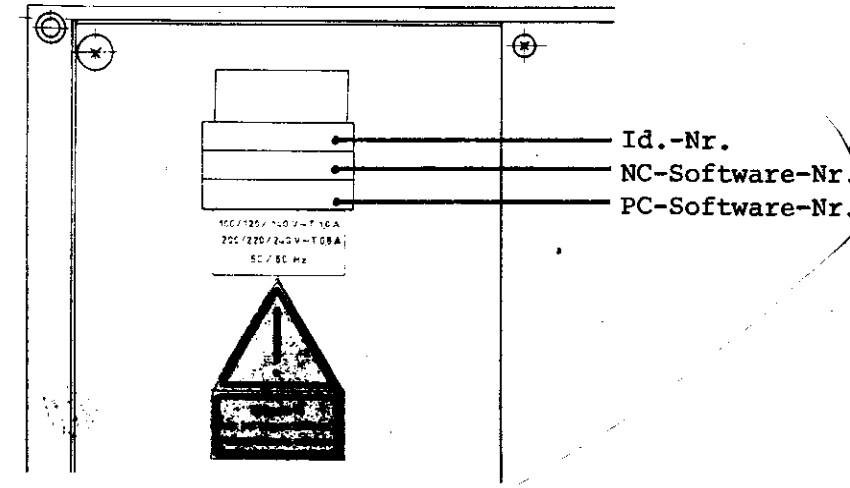
o Push screwdriver blade carefully between EPROM and socket, remove EPROM with extraction tool and place onto MOS protection mat.

o Insert EPROM into appropriate socket using insertion tool.

Important:
- When exchanging EPROMs, observe the position number (second to last digit of the programmed EPROM Id. No., hexadecimal counting manner)
- The EPROM package index must point in the same direction as the ICs on the board.
- Visually check if the EPROMs are contacting their respective sockets after an exchange.

- After the software exchange has been concluded, the Id. Nos. of the NC- and PLC-software have to be changed. The description plate for the software numbers is found on the rear of the Control under the type-plate.

The Id. No. always ends with ... ... 99.



The Id. No. of the Control changes only when a Control is converted from:

TNC 150 A to TNC 150 B
TNC 150 E to TNC 150 F
TNC 150 P to TNC 150 Q
TNC 150 V to TNC 150 W
by use of "B" or "F" type NC Software.

The RAM memory of the Memory Board is unbuffered during the EPROM (software) exchange. The machine parameters and any stored user-program are therefore erased!

For continued operation, the machine parameters have to be re-entered into memory.

3.4 Replacement Parts, Loan/Exchange/Service Units

Replacement Parts TNC 150

Unit	Id. No.
TNC 150 A/E	222 129 ---
TNC 150 B/F	225 012 --
TNC 150 P/V	222 128 --
TNC 150 Q/W	225 013 --
TNC 150 AR/ER	224 413 --
TNC 150 BR/FR	226 472 --
TNC 150 PR/VR	224 414 --
TNC 150 QR/WR	226 474 --
PL 100 B	223 836 --
PL 110 B	223 216 --
Display Unit BE 111	212 300 --
Display Unit BE 211	222 674 --

Assembly	Id. No.
Connector Board	221 720 --
Keypad Board	219 441 --
Memory Board	222 506 --
Main Processor Board	222 509 --
CLP Processor Board	221 678 --
PLC-Interface Board	222 044 --
SE-Board	221 744 --
Analogue Board	222 502 --
Analogue Board TTL	223 550 --
Power Supply Unit (backplate of housing with Power Supply Unit and Terminal Board)	

Loan, Exchange, Service Units

In order to keep machine down-time as short as possible, HEIDENHAIN offers a loan and exchange service.

Loan units
Loan units are available for the duration of the repair time free of charge. The only charges to the customer are the shipping charges.

Exchange units
An exchange unit can be requested for a unit that is returned for repair. This exchange unit is equipped with the latest hardware and software issue and is externally in excellent condition. The only charges to the customer in this case are for the repair of his own unit.

Transaction
Requested loan or exchange units are shipped on the date of request, or the following day, provided that the unit is available from our stock.
A customer's faulty unit should be returned to DR. JOHANNES HEIDENHAIN within 14 days of receiving the exchange unit.

Service units
Service units are new units which are used for service purposes and can be obtained from DR. JOHANNES HEIDENHAIN at non-repeatable discount prices.

4. Additional Information

4.1 Block Diagram Description

General
The TNC 150 block diagram shows, in simplified form, the internal functional units of the control, their relationship to the various boards, and their interconnections. The graphic layout of the diagram and the way it is included in single sheets.
- the representation of any of the TNC 150 models (A/AR/P/PR),
- simplified representation of functional processes

Numbers enclosed in dashes inform about the board and its functional unit.
e.g.: -50.1-
- 1 → Subdivision of functional unit
- 50 → Functional Unit
- - → Board

Simplified Description of the TNC 155 (Block Diagram)

- Keypad Board (1)
- Memory Board (2)
- Main Processor Board (3)
- CLP Processor/Graphic Board (4)
- Analogue Board/Analogue Board TTL (5)
- with SE Board (6) it corresponds to a A(E)-Type;
- without SE Board, with PLC Interface (6), however
- with PLC I/O-Board(s), it corresponds to a P(V)-Type or, respectively, PR(VR)-Type
- Power Supply Board (7)
- Terminal Board (8)

The functional processes of the control are divided between two microprocessor systems, each comprising:
- Microprocessor (TMS 9995)
- Program Memory (EPROMs)
- Write-Read Memory (RAMs)
- Input/Output facilities (e.g. keypad, screen, measuring system inputs, analog outputs, LEDs, V.24 interfaces etc.)

The functions of the control are divided between the two microprocessor systems as follows:

1. **"Main Processor System"**
   - Keyboard, LEDs
   - User Program Interpreter
   - Provision of programming "environment"
   - Generation of PLC program addresses
   * - Transfer of input and output states between PLC Interface Board, SE Board and PLC RAM
   * - Control of the V.24 interface

2. **"CLP-Processor System"**
   - Ascertainment of instantaneous positions
   - Interpolation Calculations
   - VDU Control
   * - Demand Speed Values to DAC

* Serial data transfer via CRU bus.

Main Processor Unit

- Primarily on the main processor board and the memory board.
- The operating system software is held in EPROMs:

-30.1-	IC-P4 (not mapped)	
-30.3-	IC-P5...IC-P8	Main Proc. Board
-30.3-	IC-P10 (dialogue language)	
-20-	IC-P11...IC-P18	Memory Board

- The RAMs -30.2- on the main processor board can be accessed either by the main processor -30- or by the CLP processor -40-. The intended coordinates, programmed feed, display texts etc. can therefore be transferred.
  These RAMs also serve as register file memory for the main processor -30-.
  User programs, machine parameters, and (under certain circumstances) the PLC program are programmed in RAMs -20.1-.

- The 16-bit address bus is extended to 20-bit by a memory mapper -31-.

- The keyboard controller -32- has the task of driving the LEDs and scanning the keypads -32.1- on the front plate.

- The main processor is connected with V.24 interface -34- via a (serial) CRU-bus. This interface is used to exchange data by means of a magnetic tape unit (ME) or, respectively, an external processor.

- The PLC program contained in IC-P9 -33.1- is processed by the "1-bit-PLC-processor" -33- mounted discretely on the main processor board. The input and output states are stored in a 4k x 1 PLC-RAM -33.2-.

- I/O-Functions:
  a) TNC 150/151/155 **A**-Versions:
  24 galvanically separated inputs (E0 to E23) -60- and 24 floating relay contact outputs (A0 to A22 + emergency stop) -61- on the SE Board. The inputs and outputs are protected on the terminal board (A version) by special protective resistances 5.1kohm -80- and 47ohm -80.1-.
  Protective resistances should never be replaced with normal resistances!
  The Analogue outputs are led via LC-filter -81- as protection against the oscillation of analogue outputs.

  b) TNC 150/151/155 **P**-Versions:
  The inputs and outputs are loaded on external PLC I/O-board (e.g. PL 100B or, respectively, PL 100B) which are driven by the main processor -30- via the PLC interface board. The data is serially transferred via the CRU-bus. All lines of this bus as well as the required addresses are galvanically separated by the optocouplers -60- and are converted from the TTL level (5V) to the MOS level (12V) by means of a level converter -61-. Thus a higher noise immunity is obtained.

  Under the control of CRU addresses 63 programmable inputs (E0 to E62) -E2- located on the PLC I/O board are multiplexed on CRUIN 1 line. If 2 PLC I/O boards are connected the inputs from the 2nd board are multiplexed on CRUIN 2. On the PLC interface board either CRUIN 1 or CRUIN 2 are selected -64- and are led to the main processor via CRUIN.

  The serial CRU OUT signal is converted in 31 outputs via a serial-parallel-converter -E1.1-. The outputs (each having its own current supervision -E1-) are transferred via line drivers to the machine interface.
  - An overloaded output only switches off during the period of the overload.
  - If the current supervision detects overcurrent no emergency-stop results in the standard PLC program.

  The input E63 is used to indicate an overloaded output to the main processor -30-.
  PL 100B: 31 unipolar, programmable outputs + emergency-stop protected against overload.
  PL 110B: 26 unipolar, programmable outputs + 5 bipolar outputs and emergency stop protected against overload.
  On the **PLC I/O board** a 12V voltage is generated by an external 24V supply. On the **PLC interface board** this 12V voltage is transformed in a 5V voltage for its TTL modules.

CLP Processor/Graphic System:

- Primarily on the CLP processor/graphic board.

- Operating system is contained in EPROM IC-P3 -40.1- (8k x 8).

- The main task is the calculation of the instantaneously intended values of the analog output voltages dependent on:
  .the instantaneous actual positions
  .the programmed intended position
  .the distance of the intended position
  (influence on deceleration ramp)
  .the programmed feed rate
  .the fast traverse rates determined per machine parameter
  .the settings of the override and feed potentiometer
  The calculating speed requires a wait-free RAM -40.2-.

- The measuring system signals are processed on the analog board. These signals are amplified at first -50.1- and then subdivided -50- by delaying (phase shifted) and combining them differently. The subdivided 0 degree, 90 degrees and RI signals are then led to the gate arrays -42- of the CLP processor board. The gate arrays consist of different gates and counters whose direction of the axis movement and the number of pulses is calculated. This information can then be scanned by CLP processor -40- to ascertain the actual values of the axes.

- The symmetry, the on-to-off ratio and the amplitude of the system signals are constantly controlled by a supervision circuit -50-.

- If the distance between the control and measuring system is more than 20m, an EXE has to be interposed. The measuring signals are thus already amplified, subdivided, evaluated, supervised and converted in TTL signals. An "R" version of the control is used accordingly (e.g. TNC 150 AR) equipped with a combined EXE connection for X-, Y-, and Z-axis and an analog board TTL. The input amplifiers and the wiring for the signal subdivision are replaced with line receivers -50- on this analog board whose outputs are directly connected to the gate arrays -42- on the CLP processor board. The supervision signal of the EXE is also buffered -50- and transferred to the CLP processor board. The signals of the handwheel are likewise processed -53- as on the "normal" (sine) analog board.

- If instead of linear position transducers incremental encoders are used to ascertain actual values a reference pulse appears once per revolution. Since only one reference pulse is to be evaluated all other reference pulses of the axes X, Y, Z, IV are inhibited on the analog board -50-. The signal lines are connected with the analog board via the PLC I/O board and the PLC interface board. The level conversion MOS/TTL as well as the galvanic decoupling is carried out on the PLC interface boards via -61- and -60-.

- The data of the CLP processor is transferred to the analog outputs via the serial CRU bus. The digital output values calculated for all axes are multiplexed on the CRU OUT line and are converted in a 12 bit parallel format on the analog board. These successive digital values are then converted in analog values (voltages) by means of a DAC -52.1- (digital-analog-converter). These voltages are compared with the adjusted values of the override and feed potentiometers -52- and the results are transmitted to the CLP processor via CRUIN. The output voltages can thus be adapted to the values adjusted by the override or, respectively, the feed potentiometer. The X-, Y-, Z-, IV- and S-analog values generated shortly one after the other at the output of the DAC are allocated to the single axes by means of five sample and hold circuits -52.2-. The five individual analog voltages are amplified and buffered subsequently -52.3- and are led to the terminal board.

- On the analog board the buffer battery (3,46V) and the internal temperature (65°) of the control are also supervised -51-. The supervision signals are led to the CLP processor via the CRUIN line.

- Two "watch dog" monoflops -51.1- are on the analog board. These must be triggered separately once every 5ms by the CLP processor -40- and once every 20ms by the main processor -30-. If the monoflops are not driven within 5ms or 20ms (error state), an emergency-stop signal is triggered.

- The drive of the screen is another important task of the TNC 150 CLP processor. It only has to write the texts to be displayed into the CRT RAM -41.1-. A special CRT controller TMS 9937 -41- generates the necessary addresses for the CRT RAM and the character generator IC-P1 -41.2- so that the data are transferred to the shift register -41.3- in the right sequence. Thus signal can be inverted by means of an exclusive-or-gate -41.4- to generate an inverse video display. The video signal, the bright/dark signal, the horizontal/vertical sync. signals and an 11V supply are used to operate the screen.

Power Supply Unit

- +5V are generated for the TTL modules via the forward converter -70-. The flyback regulator -70.1- inductively coupled with the flow converter generates +/-15V for the operation amplifier.

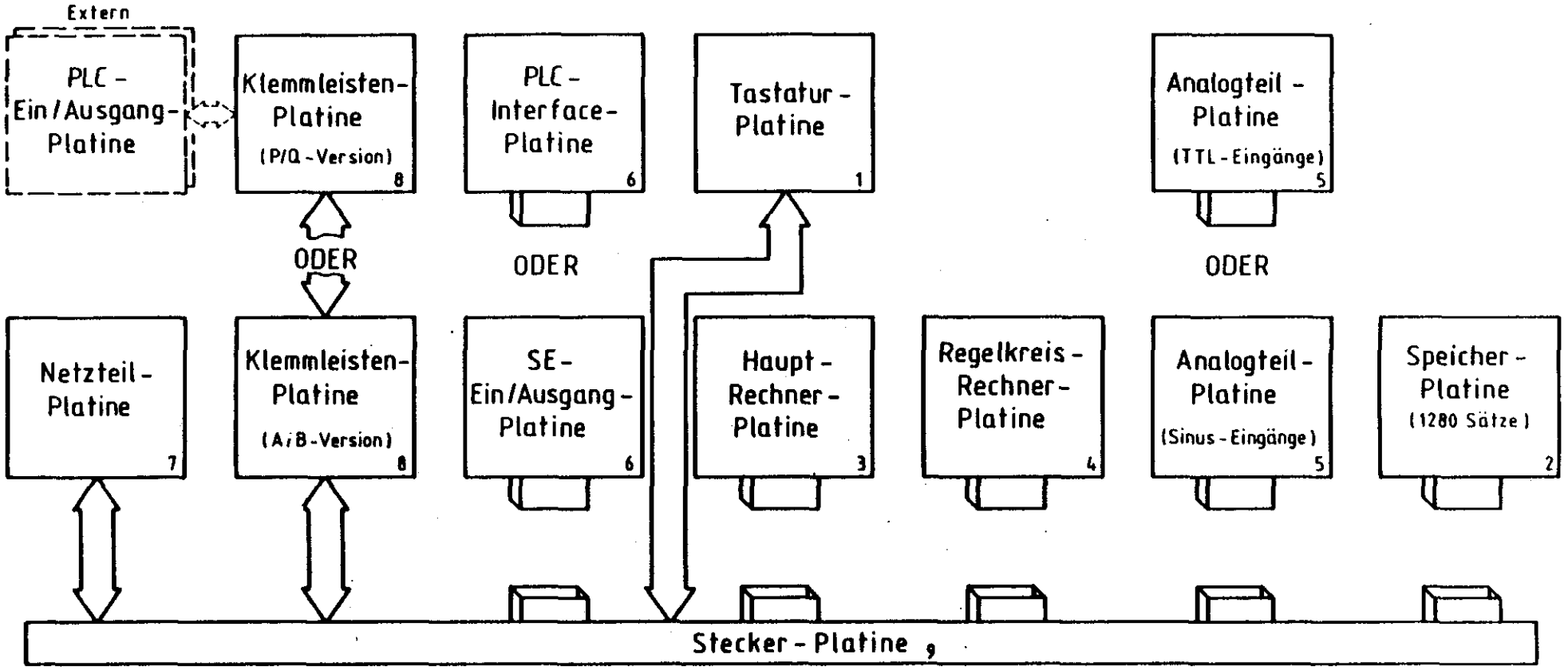
- The +12V supply voltage for the V.24 interface is generated with the help of the +15V by menas of a linear regulator -70.2-.

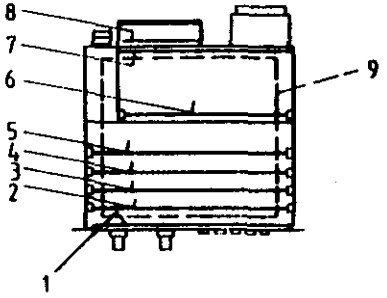
- +11V are generated via the forward converter -70.3- for the TNC 150 (BE 111, BE 211) screen. The switch regulator -70.01- and -70.31- readjust the output voltage load controlled.

- The soft start -71- limits the relatively high switch-on current.

- On the power supply board there is, moreover, a voltage supervision -72- triggering a reset signal if the power supply is interrupted or if the supply voltage drops below a predetermined minimum level (187V if set for 220V operation) for a short time.
  If U2 (+5V) exceeds if there is a failure the overvoltage recognition -73- is immediately effective and causes the overvoltage protection (thyristor) -73.1- to connect through. Thus U1 is short-circuited coming directly from the power supply transformer -74- via the rectifier -75-. A greater damage at the subsequent electronics is thus inhibited by means of this protective measure.

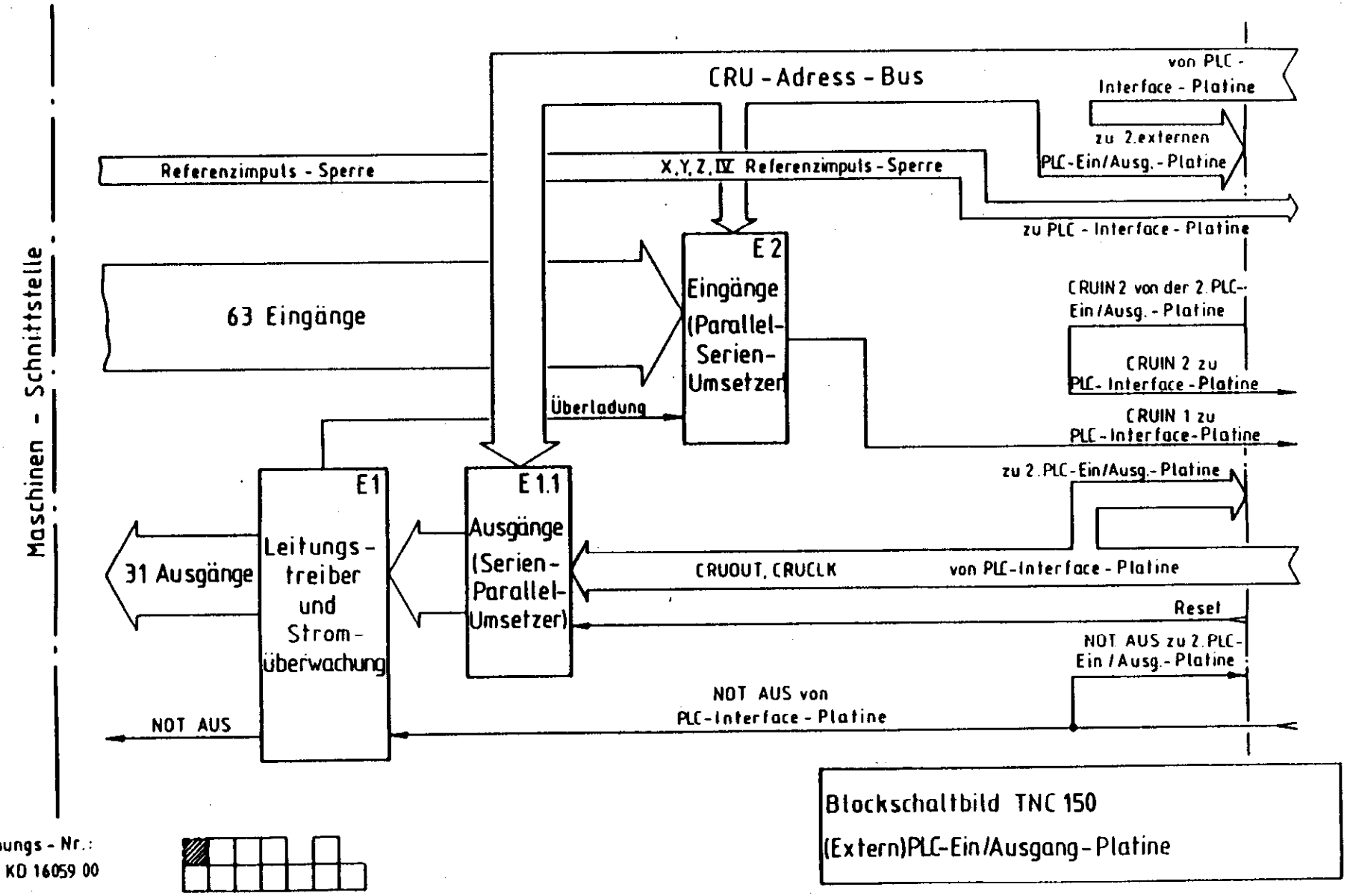
4.2 Block Diagram TNC 150

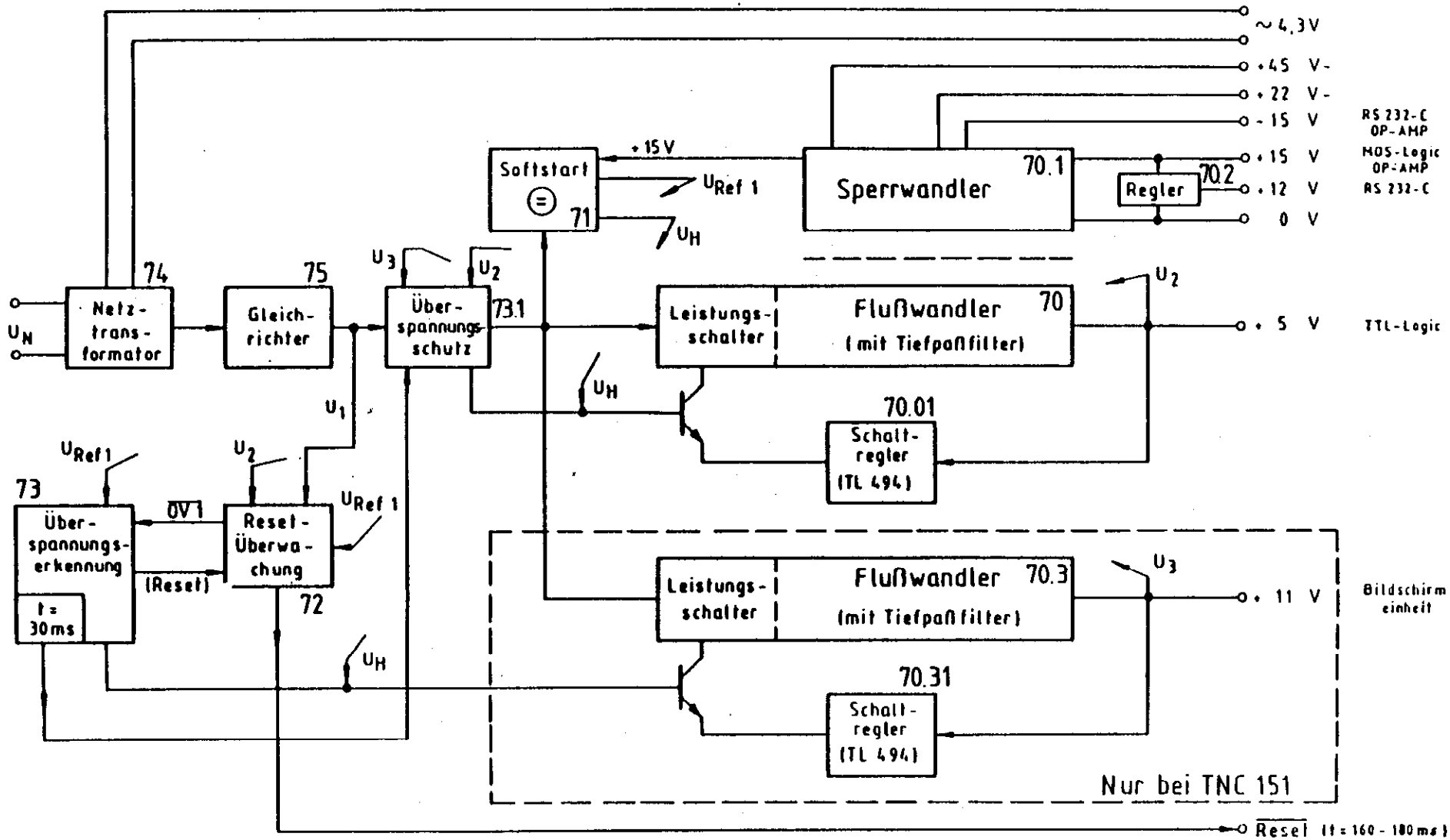




Zeichnungs - Nr.:
4820 E KD 16063 00

Anordnung der Blockschaltbilder
und Platinen für TNC 150

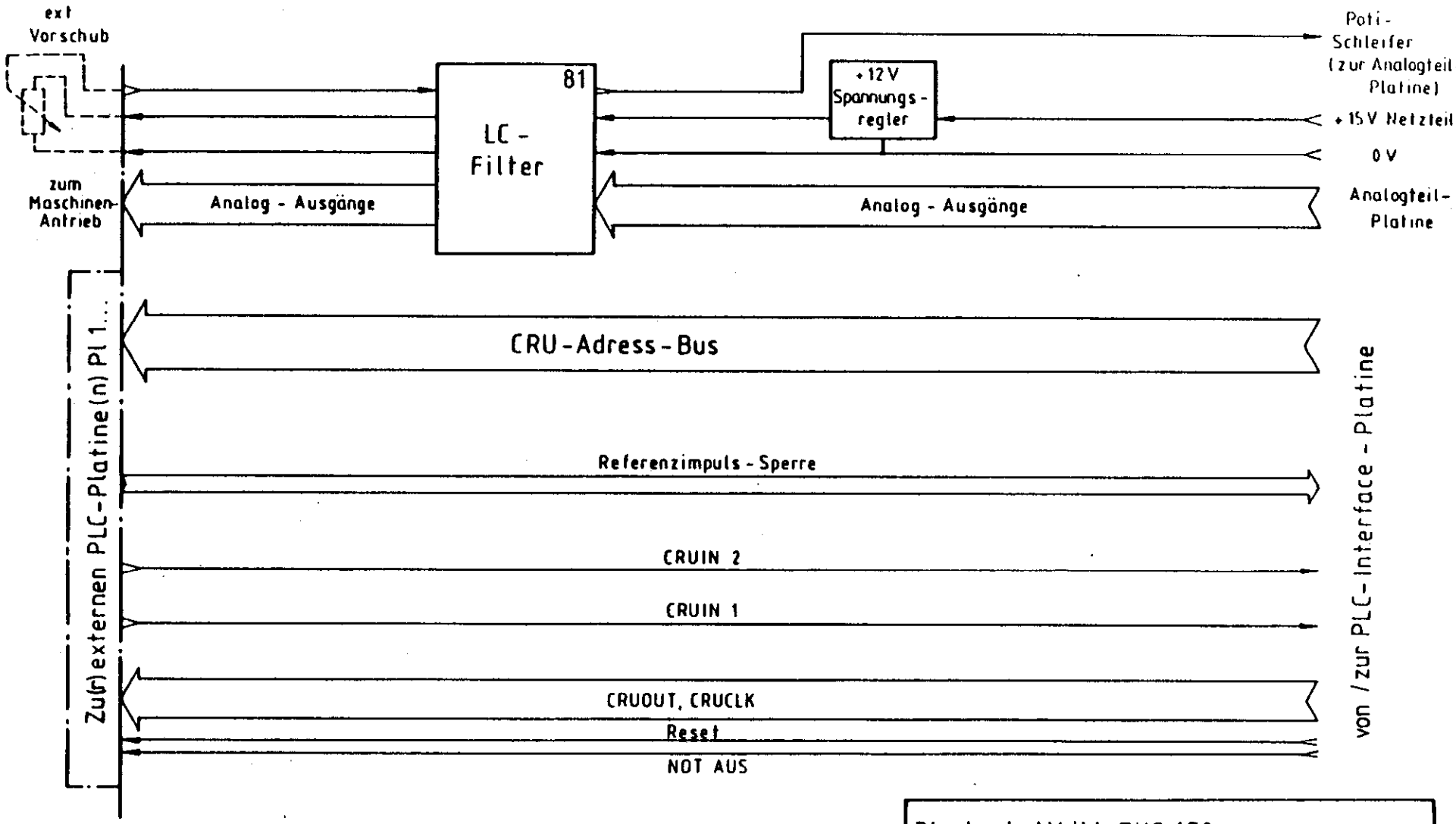

Maschinen - Schnittstelle
CRU - Adress - Bus
von PLC - Interface - Platine
zu 2.externen PLC-Ein/Ausg.-Platine
Referenzimpuls - Sperre
X,Y,Z,IV Referenzimpuls - Sperre
zu PLC - Interface - Platine
63 Eingänge
E 2
Eingänge (Parallel-Serien-Umsetzer)
CRUIN 2 von der 2. PLC-Ein/Ausg. - Platine
CRUIN 2 zu PLC - Interface - Platine
Überladung
CRUIN 1 zu PLC - Interface - Platine
zu 2. PLC - Ein/Ausg. - Platine
E1
E 1.1
31 Ausgänge
Leitungs-treiber und Strom-überwachung
Ausgänge (Serien-Parallel-Umsetzer)
CRUOUT, CRUCLK
von PLC-Interface - Platine
Reset
NOT AUS zu 2. PLC-Ein/Ausg.-Platine
NOT AUS von PLC-Interface - Platine
NOT AUS
Blockschaltbild TNC 150
(Extern)PLC-Ein/Ausgang-Platine
Zeichnungs - Nr.:
4820 E KD 16059 00



Zeichnungs - Nr.:
4820 E KD16064 00

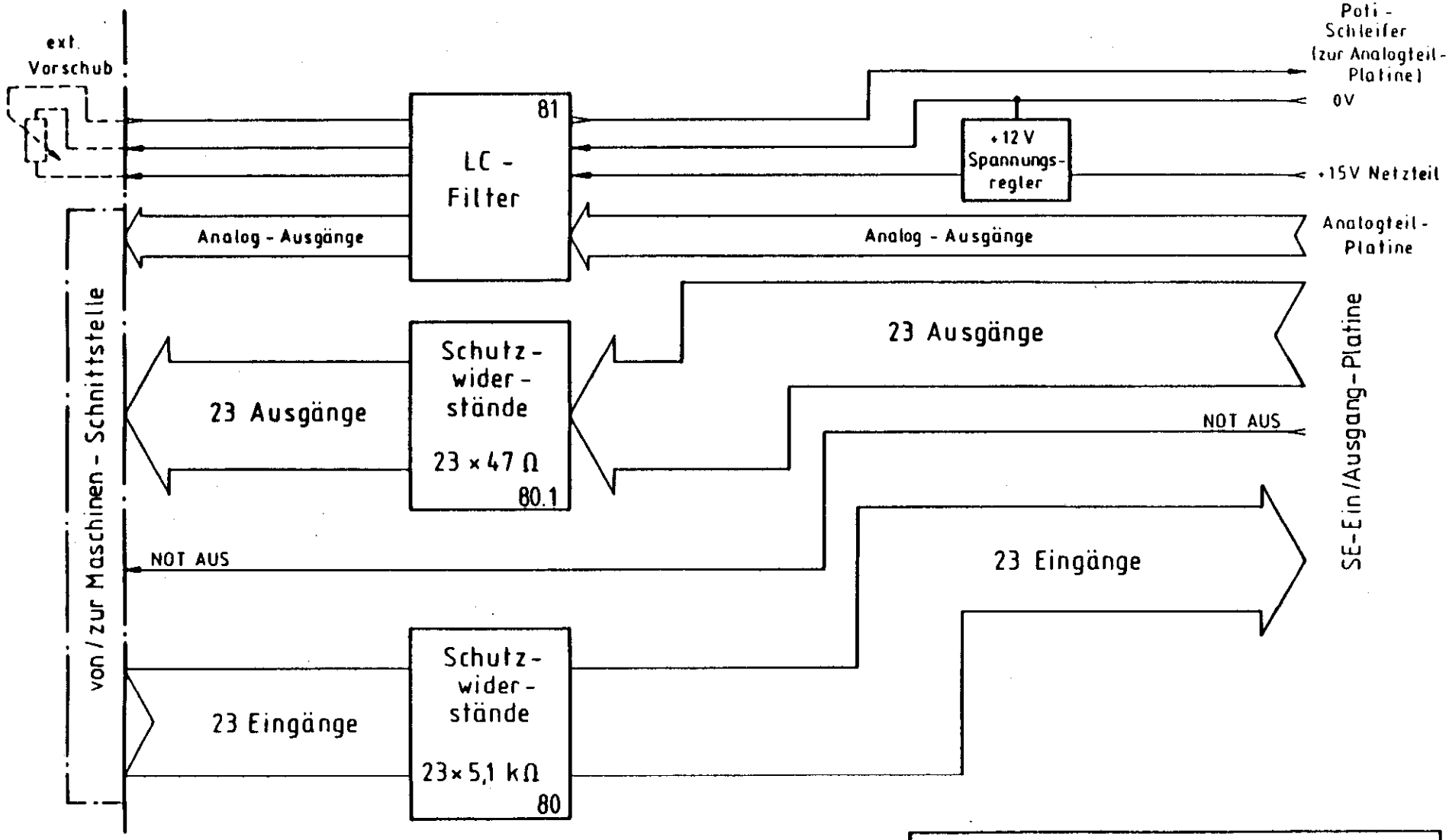
Blockschaltbild TNC 150

Netzteil



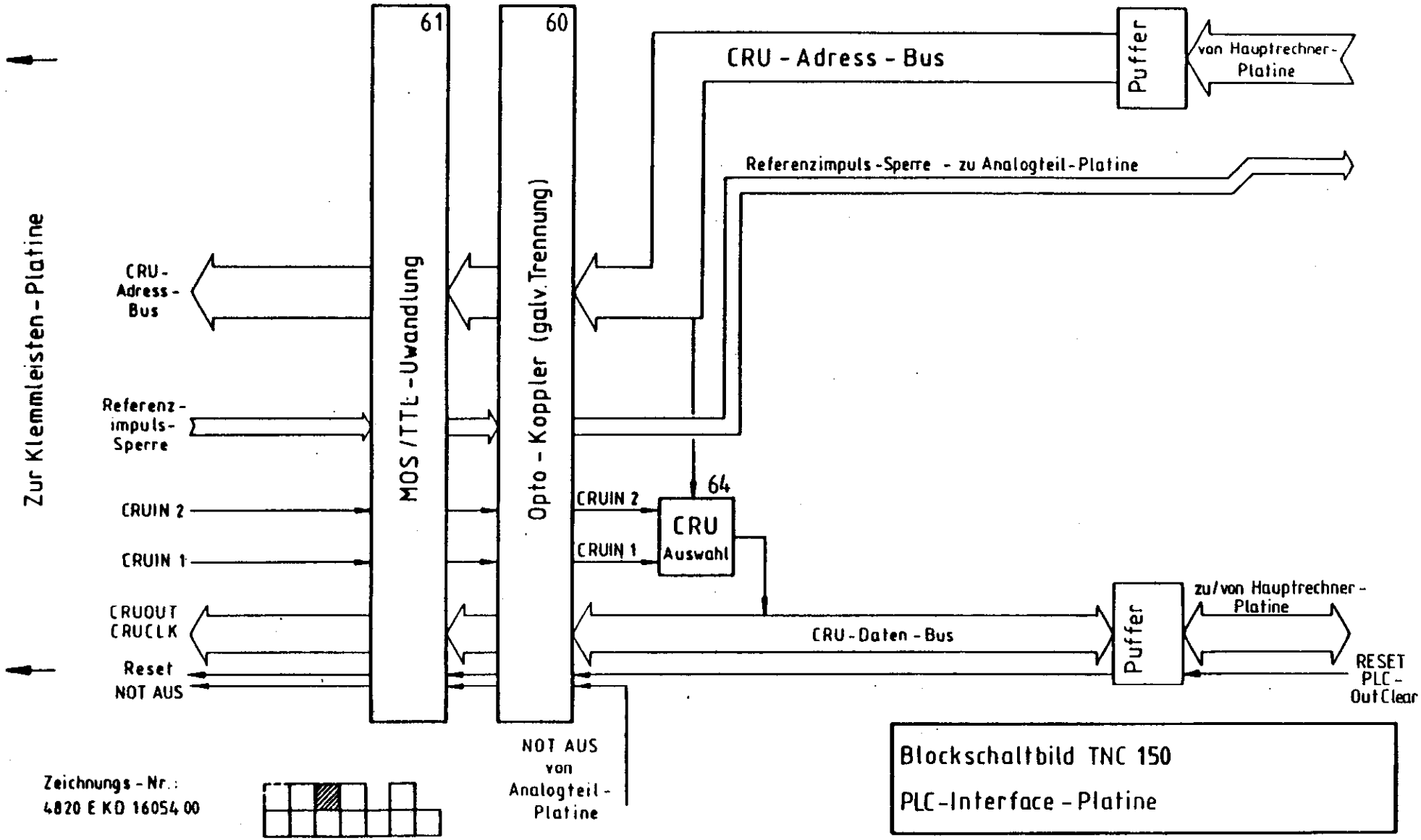
Zeichnungs - Nr.:
4820 E KD 16057 00

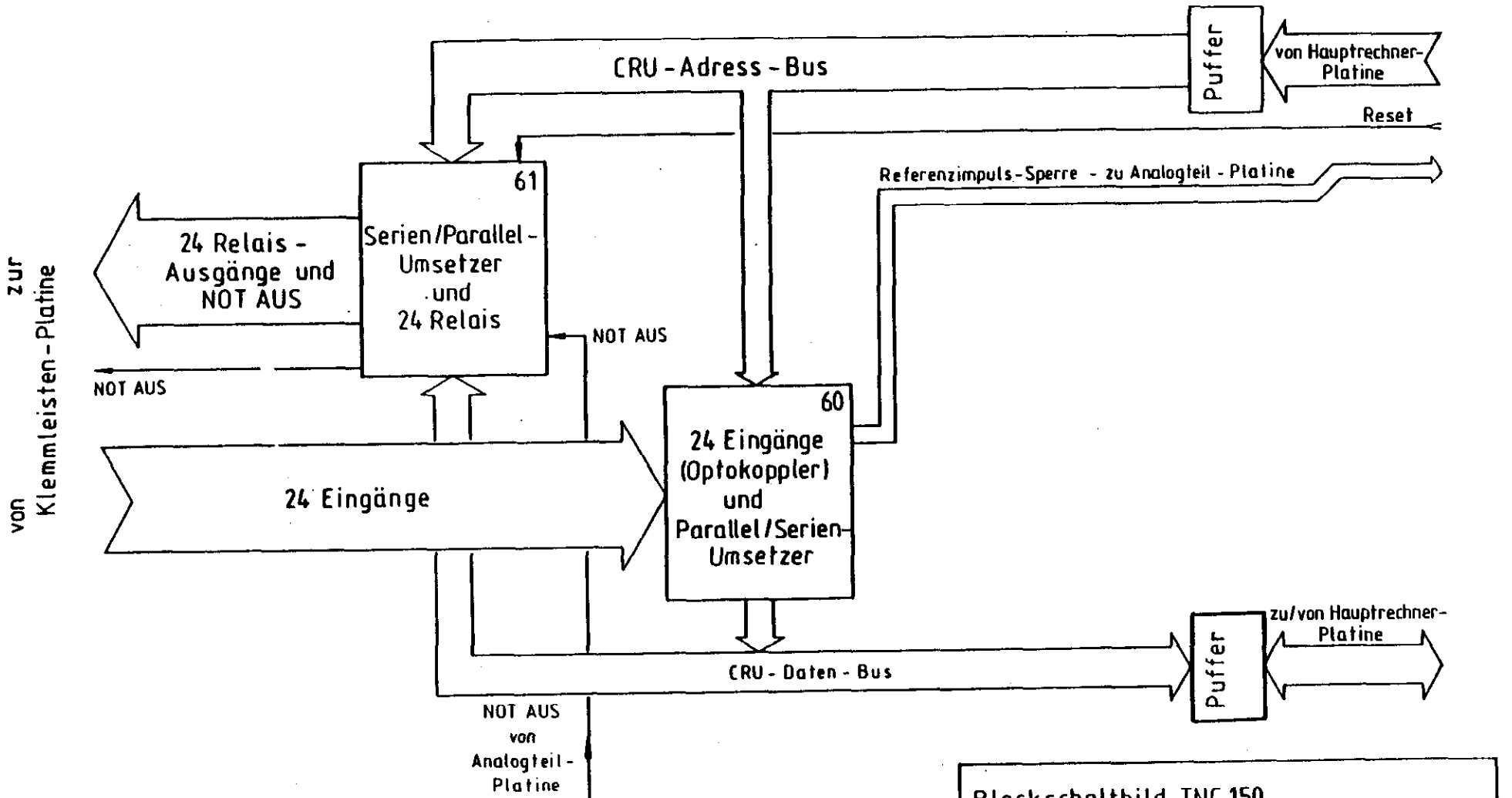
Blockschaltbild TNC 150
Klemmleisten-Platine (P-Version)



Zeichnungs - Nr.:
4820 E KD 16058 00

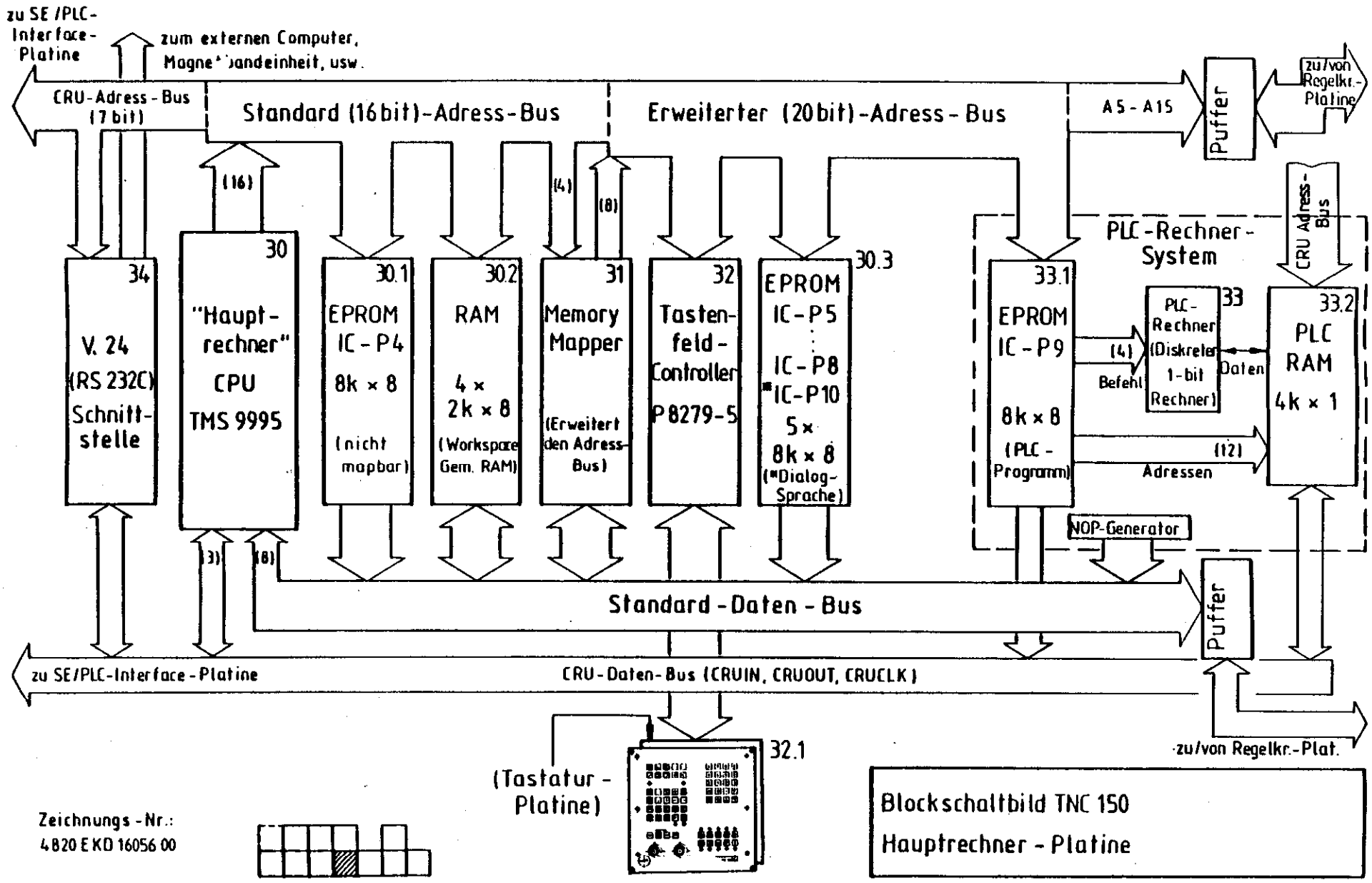
Blockschaltbild TNC 150
Klemmleisten - Platine (A-Version)


Zur Klemmleisten-Platine
61
60
MOS/TTL-Uwandlung
Opto-Koppler (galv. Trennung)
CRU-Adress-Bus
Puffer
von Hauptrechner-Platine
Referenzimpuls-Sperre - zu Analogteil-Platine
CRU-Adress-Bus
Referenz-impuls-Sperre
CRUIN 2
CRUIN 1
CRUOUT
CRUCLK
Reset
NOT AUS
64
CRU Auswahl
CRU-Daten-Bus
Puffer
zu/von Hauptrechner-Platine
RESET PLC-Out Clear
NOT AUS von Analogteil-Platine
Zeichnungs-Nr.:
4820 E KD 16054 00
Blockschaltbild TNC 150
PLC-Interface-Platine



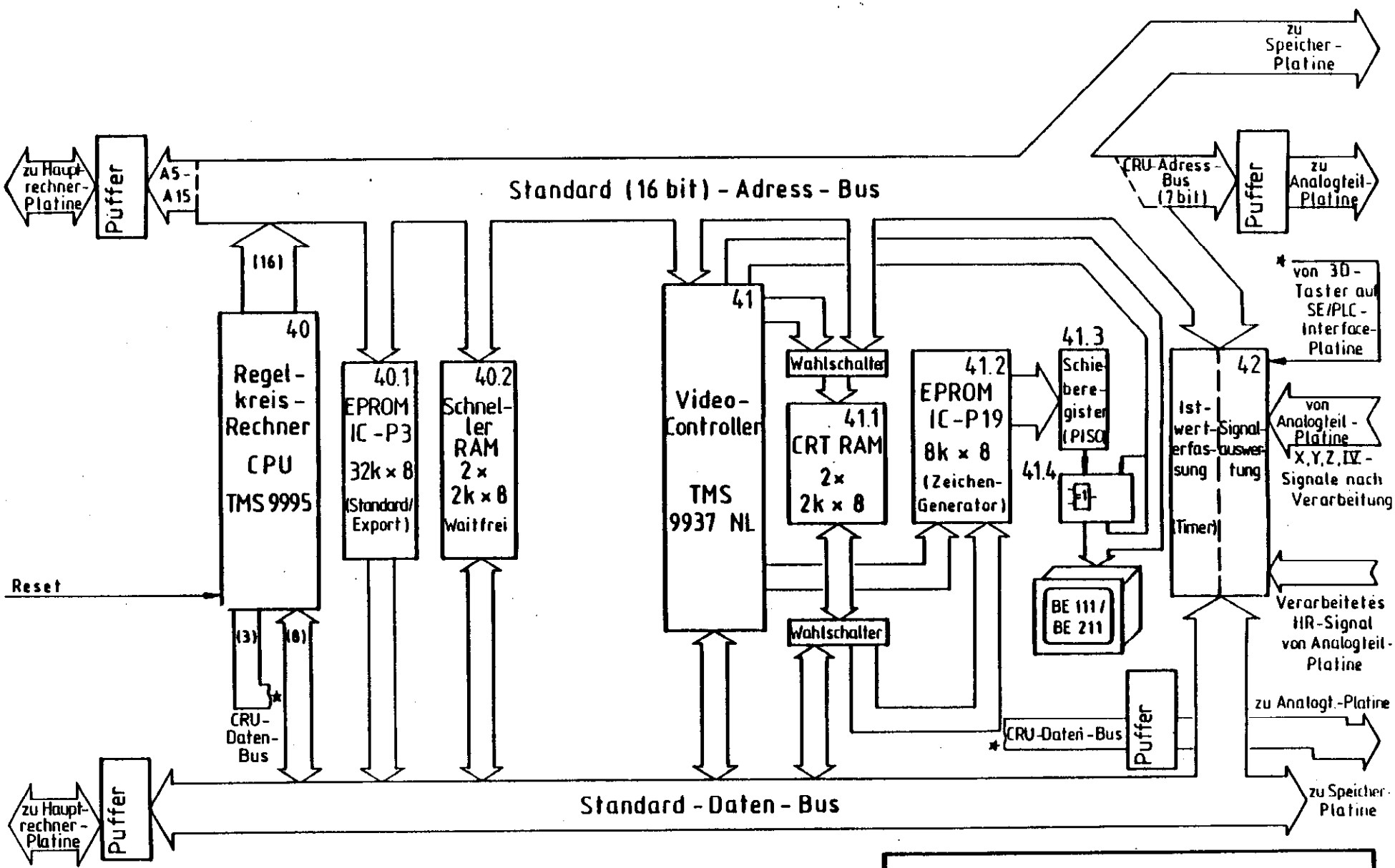
Zeichnungs - Nr.:
4820 E KD 16055 00

Blockschaltbild TNC 150
SE - Ein /Ausgang - Platine



Zeichnungs-Nr.:
4820 E KD 16056 00

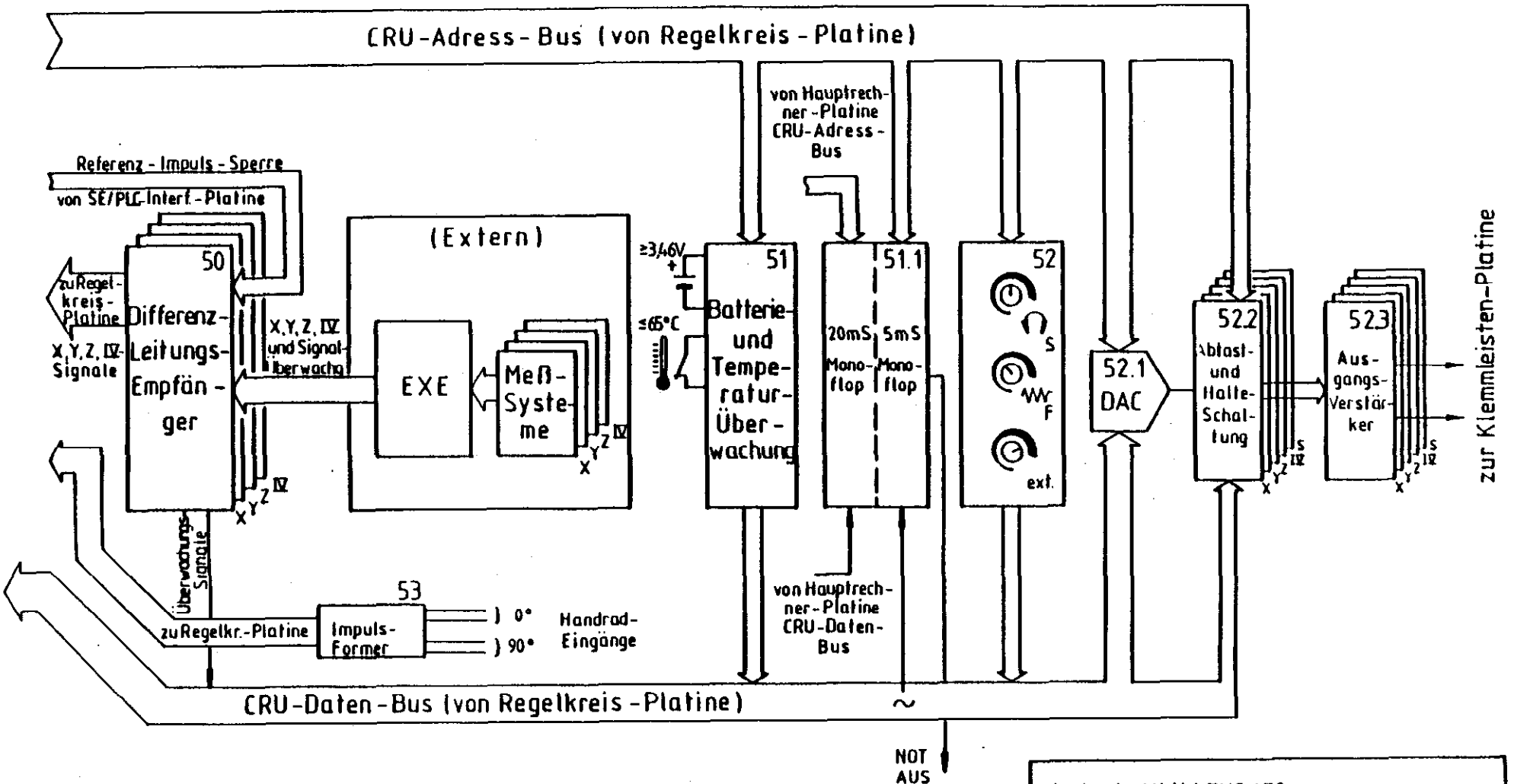
Blockschaltbild TNC 150
Hauptrechner - Platine



Blockschaltbild TNC 150

Regelkreis - Rechner - Platine

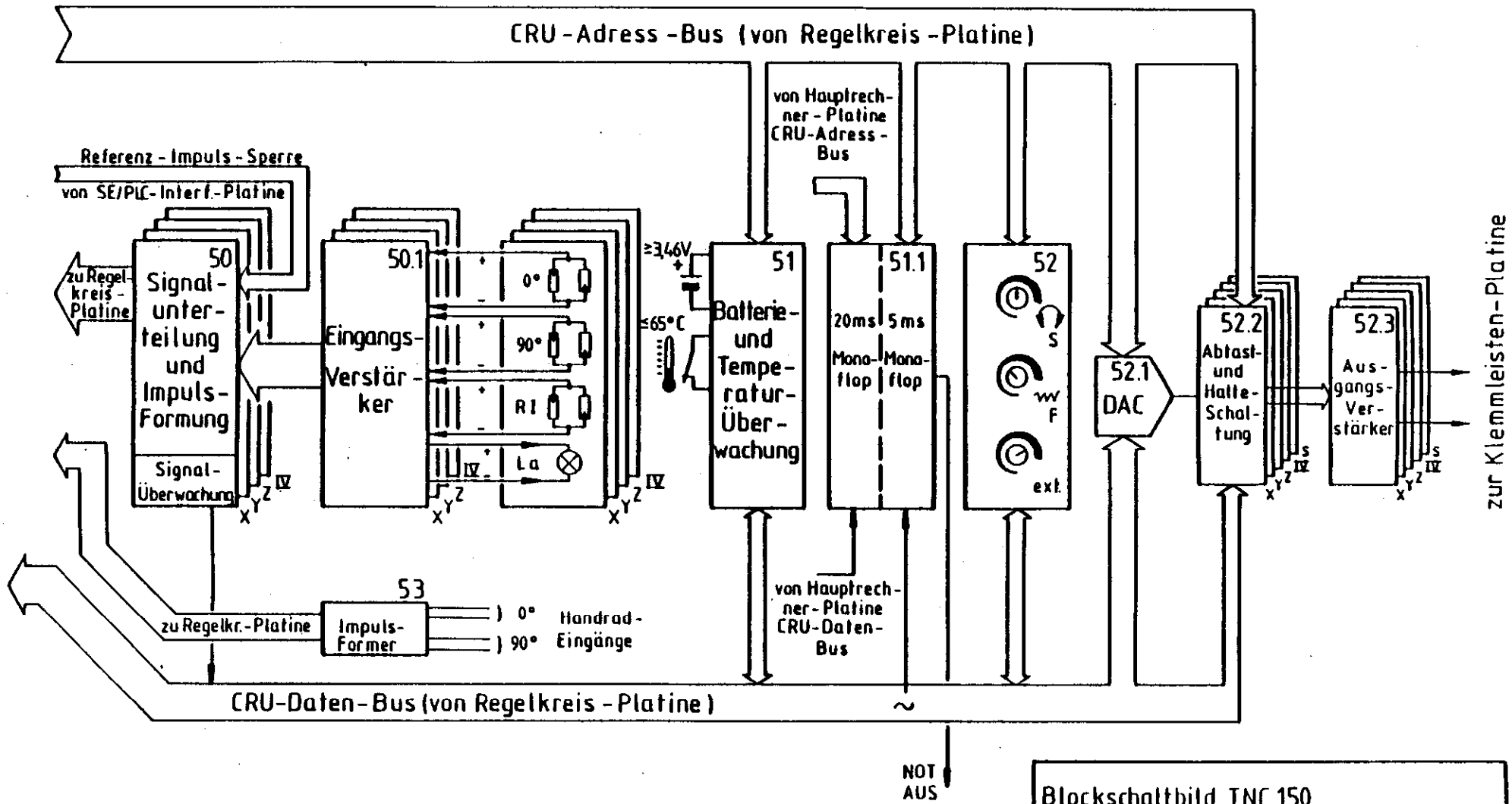
Zeichnungs - Nr.:
4 820 E KD 16062 00



Zeichnungs - Nr.:
4820 EKD 16060 00

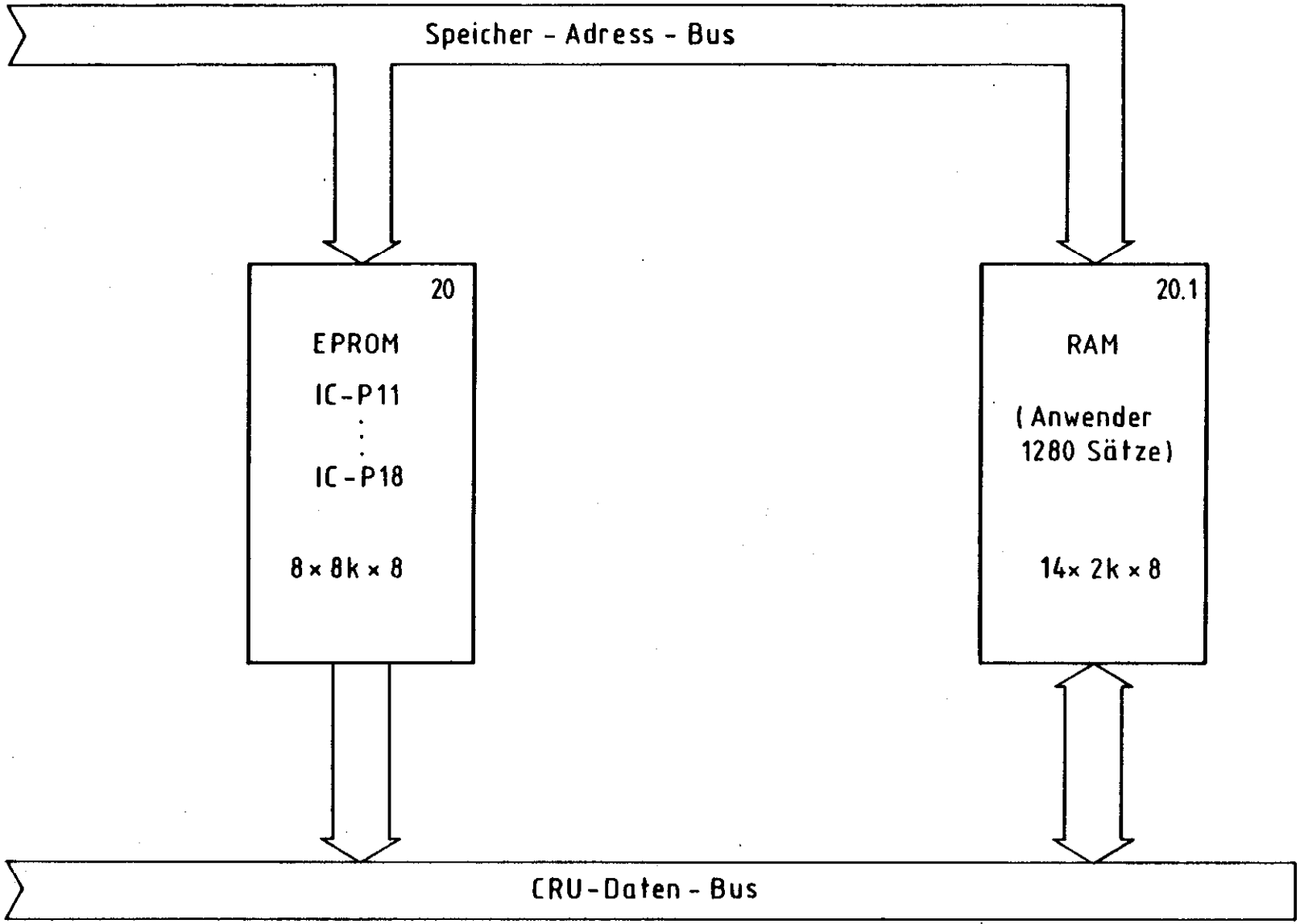
Blockschaltbild TNC 150

Analogteil - Platine (TTL-Eingänge)



Zeichnungs - Nr.:
4820 E KD 16061 00

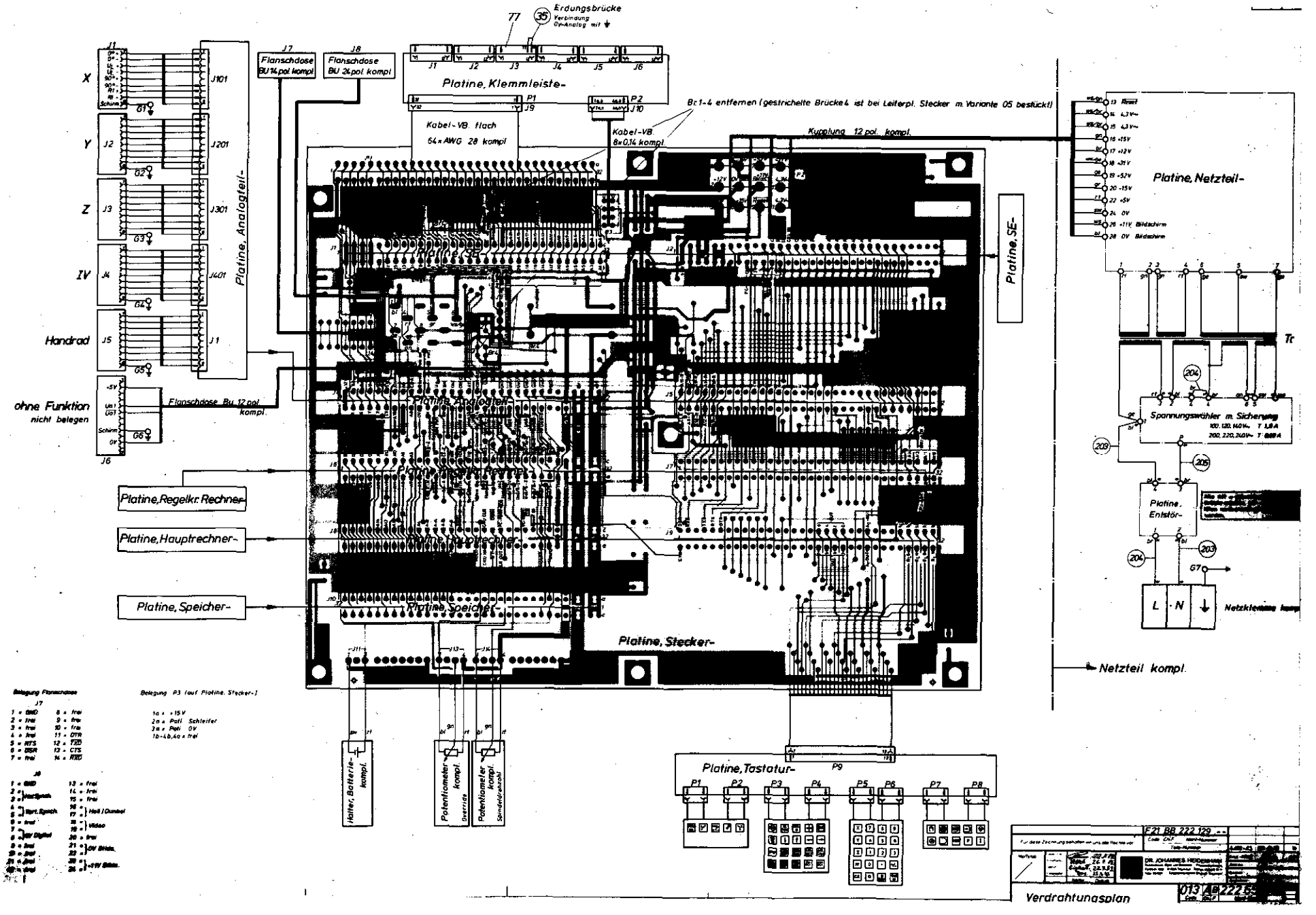
Blockschaltbild TNC 150
Analogteil - Platine

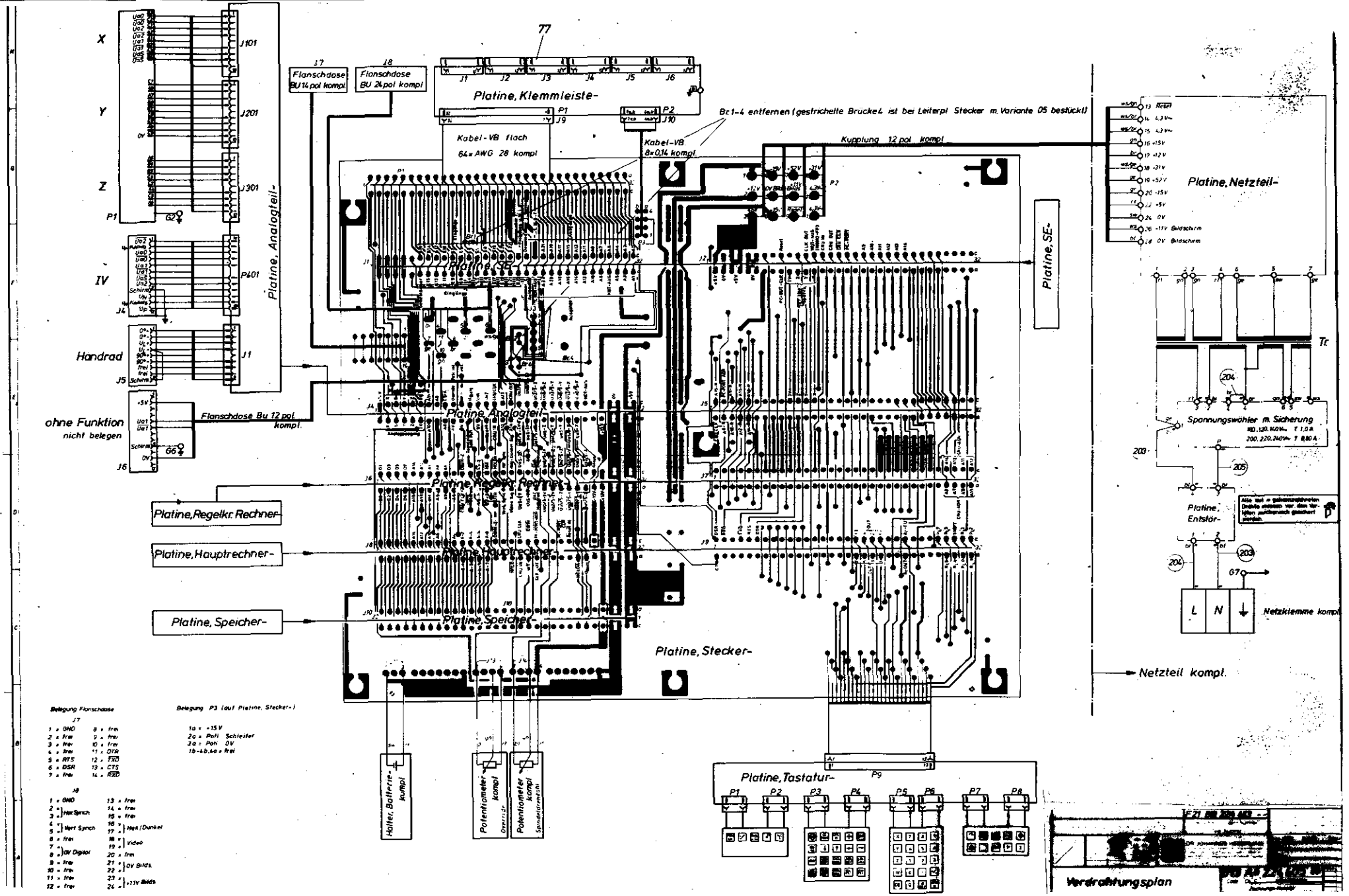


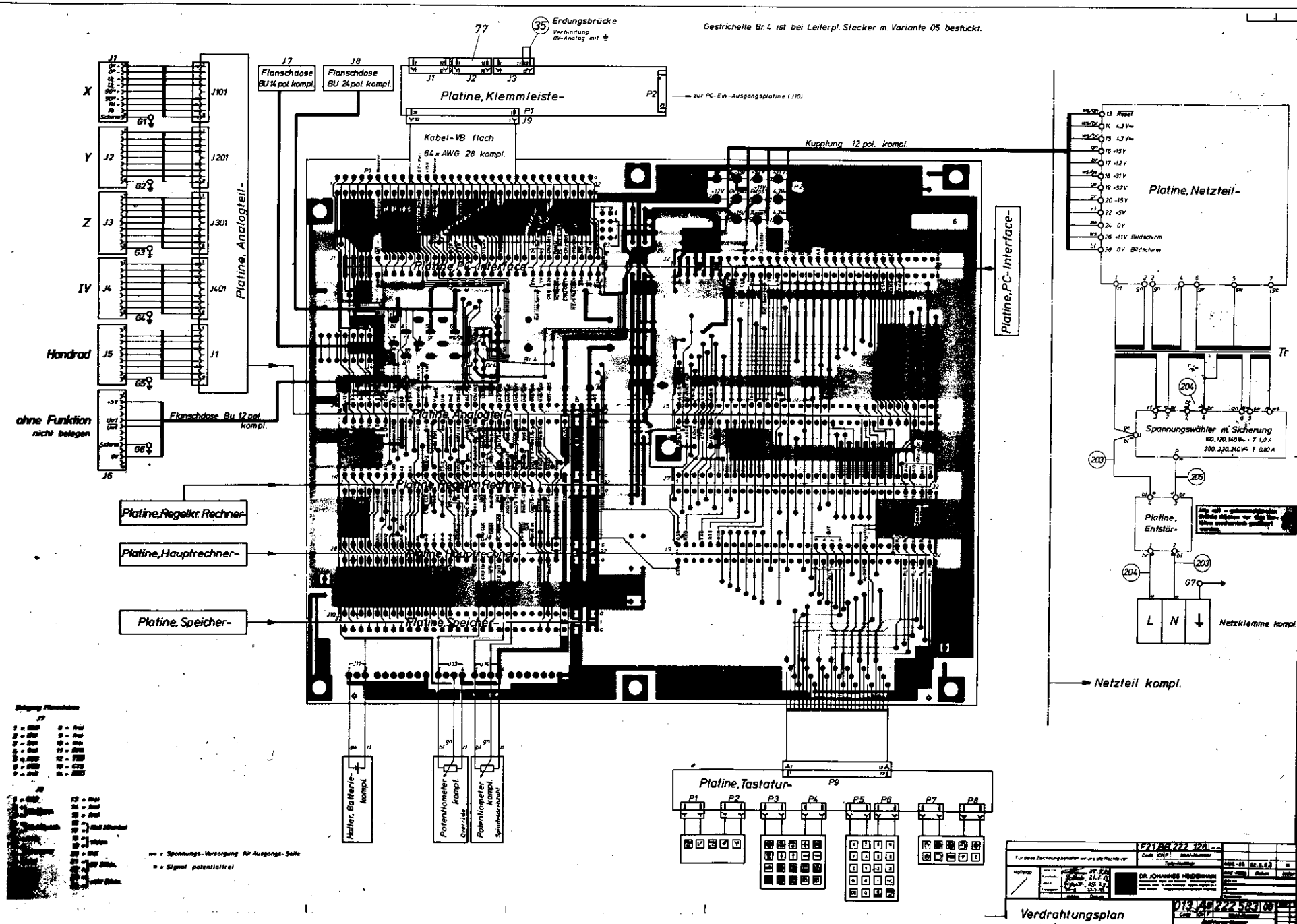
Zeichnungs - Nr.:
4820 E KD 16053 00

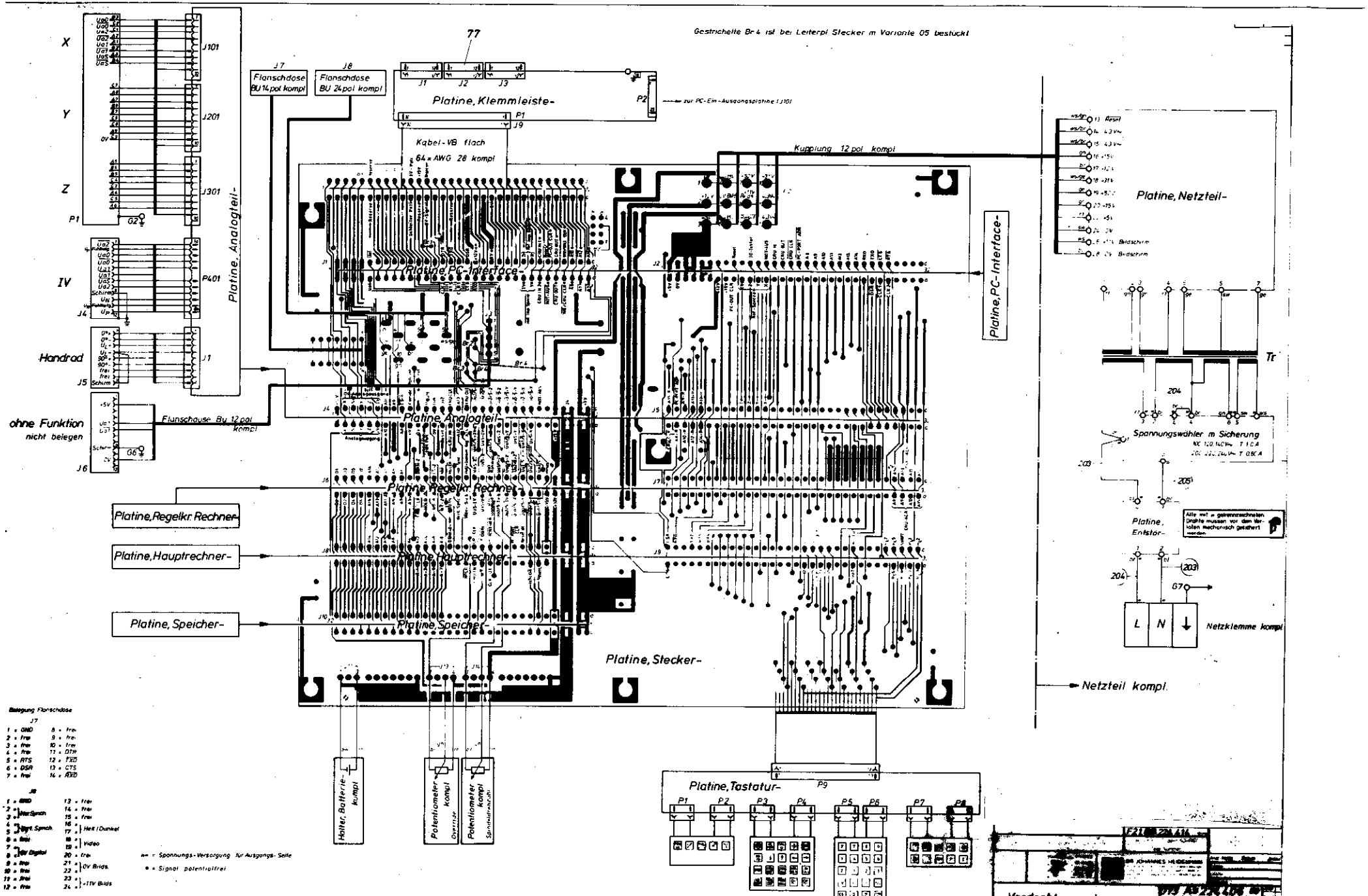
Blockschaltbild TNC 150
Speicher - Platine

4.3 Wiring Diagrams


Platine, Analogteil-
Flanschdose BU 14 pol. kompl.
Flanschdose BU 24 pol. kompl.
Platine, Klemmleiste-
Erdungsbrücke
Verbindung 0V-Analog mit ⏚
Kabel-VB flach 64 x AWG 28 kompl.
Kabel-VB 8 x 0,14 kompl.
Br 1-4 entfernen (gestrichelte Brücke 4 ist bei Leiterpl. Stecker m. Variante 05 bestückt!)
Kupplung 12 pol. kompl.
Platine, Netzteil-
Platine, SE-
Platine, Regelkr. Rechner-
Platine, Hauptrechner-
Platine, Speicher-
Platine, Stecker-
Platine, Tastatur-
Spannungswähler m. Sicherung
Platine, Entstör-
Netzteil kompl.
Verdrahtungsplan
ohne Funktion
nicht belegen
Handrad
Batterie, kompl.
Potentiometer kompl.
Potentiometer kompl.


Platine, Analogteil-
Handrad
ohne Funktion
nicht belegen
Flanschdose Bu 12 pol. kompl.
Flanschdose BU 14 pol kompl
Flanschdose BU 24 pol kompl
Platine, Klemmleiste-
Kabel-VB flach
64 x AWG 28 kompl
Kabel-VB
8 x 0,14 kompl
Br 1-4 entfernen (gestrichelte Brücke 4 ist bei Leiterpl. Stecker m. Variante 05 bestückt)
Kupplung 12 pol kompl
Platine, SE-
Platine, Netzteil-
Tr
Spannungswähler m. Sicherung
Platine, Entstör-
Netzklemme kompl.
Netzteil kompl.
Platine, Regelkr. Rechner-
Platine, Hauptrechner-
Platine, Speicher-
Platine, Stecker-
Platine, Tastatur-
Halter, Batterie- kompl.
Potentiometer kompl.
Belegung Flanschdose
Belegung P3 (auf Platine, Stecker-)
Verdrahtungsplan


Gestrichelte Br.4 ist bei Leiterpl. Stecker m. Variante 05 bestückt.
Erdungsbrücke
Verbindung 0V-Analog mit ⏚
Platine, Klemmleiste-
Kabel-VB. flach
64 x AWG 28 kompl.
Kupplung 12 pol. kompl.
Platine, Analogteil-
Platine, Analogteil
Platine, Digitalteil
Platine, Hauptrechner
Platine, Speicher
Platine, PC-Interface-
Platine, Netzteil-
Flanschdose BU 14 pol. kompl.
Flanschdose BU 24 pol. kompl.
Flanschdose Bu 12 pol. kompl.
ohne Funktion nicht belegen
Handrad
Platine, Regelkr. Rechner-
Platine, Hauptrechner-
Platine. Speicher-
Spannungswähler m. Sicherung
Platine, Entstör-
Netzklemme kompl
Netzteil kompl.
Halter, Batterie- kompl.
Potentiometer kompl. Override
Potentiometer kompl. Spindeldrehzahl
Platine, Tastatur-
Verdrahtungsplan


Gestrichelte Br 4 ist bei Leiterpl Stecker m Variante 05 bestückt
Platine, Analogteil-
Platine, Klemmleiste-
Platine PC-Interface-
Platine, PC-Interface-
Platine, Netzteil-
Platine, Regelkr. Rechner-
Platine, Hauptrechner-
Platine, Speicher-
Platine, Stecker-
Platine, Tastatur-
Kabel-VB flach
64 x AWG 28 kompl
Kupplung 12 pol kompl
Flanschdose BU 14 pol kompl
Flanschdose BU 24 pol kompl
Flanschdose BU 12 pol kompl
Handrad
ohne Funktion
nicht belegen
Spannungswähler m Sicherung
Platine, Entstör-
Netzklemme kompl
Netzteil kompl.
Halter, Batterie- kompl
Potentiometer kompl
Belegung Flanschdose

4.4 Machine Parameters

Funktion		Parameter Nr.	Eingabe-Werte
Eilgang	X	0	80 – 15 999 mm/min
	Y	1	
	Z	2	
	IV	3	(IV: Grad/min bei Achsbezeichnung A oder B oder C)
Handvorschub	X	4	
	Y	5	
	Z	6	
	IV	7	
Geschwindigkeit beim Anfahren der Referenzpunkte	X	8	
	Y	9	
	Z	10	
	IV	11	
Signal-Auswertung	X	12	1 ≙ 20fach 2 ≙ 10fach
	Y	13	
	Z	14	
	IV	15	
Verfahrrichtung beim Anfahren der Referenzmarken	X	16	0 ≙ Plus-Richtung 1 ≙ Minus-Richtung (bei richtiger Programmierung der Parameter Nr. 20 bis 27)
	Y	17	
	Z	18	
	IV	19	
Zählrichtung	X	20	0 oder 1
	Y	21	
	Z	22	
	IV	23	
Polarität der Sollwert-Spannung	X	24	0 ≙ positiv bei positiver Verfahrrichtung 1 ≙ negativ bei positiver Verfahrrichtung
	Y	25	
	Z	26	
	IV	27	
Integralfaktor	X	28	0 – 65 535
	Y	29	
	Z	30	
	IV	31	
Differenzfaktor	X	32	0 – 65,535 (Werte aus Tabelle Kapitel 6.2.2)
	Y	33	
	Z	34	
	IV	35	
Lose-Kompensation	X	36	0 – 65,535 µm ab Software-Version 03 – 1,000 mm – + 1,000 mm
	Y	37	
	Z	38	
	IV	39	
Korrekturfaktor für lineare Korrektur	X	40	– 1,000 mm/m – + 1,000 mm/m
	Y	41	
	Z	42	
	IV	43	

Funktion		Parameter Nr.	Eingabe-Werte
Software-Endschalter-Bereiche	X+	44	0 bis ± 30 000,000 mm
	X–	45	
	Y+	46	
	Y–	47	
	Z+	48	
	Z–	49	
	IV+	50	Winkelachse 0 bis ± 30 000°
	IV–	51	
Analogspannung bei Eilgang		52	+ 4,5 – + 9 Volt
Einfahr-Geschwindigkeit		53	0,1 – 10 m/min
Beschleunigung		54	0,001 – 1,5 m/s²
Kreisbeschleunigung		55	
Positions-Überwachung (löschbar)		56	0,001 – 30 mm
" (Not-Aus)		57	
Positionierfenster X, Y, Z		58	0,001 – 0,05 mm
Achsfolge bei Anfahren der Referenzpunkte		59	0 ≙ X Y Z IV 1 ≙ X Y IV Z 2 ≙ X Z Y IV 3 ≙ X Z IV Y 4 ≙ X IV Y Z 5 ≙ X IV Z Y 6 ≙ Y X Z IV 7 ≙ Y X IV Z 8 ≙ Y Z X IV 9 ≙ Y Z IV X 10 ≙ Y IV X Z 11 ≙ Y IV Z X 12 ≙ Z X Y IV 13 ≙ Z X IV Y 14 ≙ Z Y X IV 15 ≙ Z Y IV X 16 ≙ Z IV X Y 17 ≙ Z IV Y X 18 ≙ IV X Y Z 19 ≙ IV X Z Y 20 ≙ IV Y X Z 21 ≙ IV Y Z X 22 ≙ IV Z X Y 23 ≙ IV Z Y X
Geschwindigkeits-Vorsteuerung		60	0 ≙ ein 1 ≙ aus
Ausgabe der Werkzeug-Nummern		61	0 keine Ausgabe 1 nur Ausgabe, wenn sich die Werkzeugnummer ändert 2 Ausgabe der Werkzeugnummer bei jedem Werkzeug-Aufruf
Ausgabe der Spindeldrehzahl codiert oder als S-Analogspannung		62	0 ≙ keine Ausgabe von Spindel-Drehzahlen 1 ≙ Code-Ausgabe nur, wenn sich die Drehzahl ändert 2 ≙ Code-Ausgabe sämtlicher Drehzahlangaben 3 ≙ S-Analogspannungs-Ausgabe, Getriebe-Schaltsignal nur, wenn sich die Getriebestufe ändert 4 ≙ S-Analogspannungs-Ausgabe, Ausgabe Getriebe-Schaltsignal bei jedem Werkzeug-Aufruf 5 ≙ S-Analogspannungs-Ausgang ohne Getriebe-Schaltsignal
Begrenzung Drehzahl-Code		63	01991
Einschwingverhalten beim Beschleunigen		64	0,01 – 0,999
Anzeigeschritt		65	0 ≙ 1 µm 1 ≙ 5 µm
Externes Vorschub-Potentiometer		66	0 ≙ internes Potentiometer für Override und Handvorschub 1 ≙ externes Potentiometer für Override und Handvorschub 2 ≙ internes Potentiometer für Override externes Potentiometer für Handvorschub
Verweilzeit Drehrichtungs-Umkehr Arbeitsspindel für Zyklus "Gewindebohren"		67	0 – 65,536 s

Funktion	Parameter Nr.	Eingabe-Werte
Speicherfunktion für Richtungstasten	68	0 ≙ aus 1 ≙ ein
Sonderablauf für das Anfahren der Referenzpunkte	69	0 ≙ aus 1 ≙ ein
Sollwert-Spannung für Spindelantrieb beim Getriebeschalten	70	0 – 9,999 Volt
Programm-Ende-Zeichen	71	1 – 126 (je nach der Wertigkeit des entsprechenden Zeichens auf dem Lochstreifen)
Auswahl der für das Steuern gesperrten Achsen	72	0 ≙ keine Achse gesperrt 1 ≙ X– " " 2 ≙ Y– " " 3 ≙ X–, Y– " " 4 ≙ Z– " " 5 ≙ X–, Z– " " 6 ≙ Y–, Z– " " 7 ≙ X–, Y–, Z– " " 8 ≙ IV– " " 9 ≙ X–, IV– " " 10 ≙ Y–, IV– " " 11 ≙ X–, Y–, IV– " " 12 ≙ Z–, IV– " " 13 ≙ X–, Z–, IV– " " 14 ≙ Y–, Z–, IV– " " 15 ≙ X–, Y–, Z–, IV– " "
Vorabschalt-Zeit Vorschub für Zyklus "Gewindebohren"	73	0 – 65,535 s
Override wirksam bei Betätigen der Eilgang-Taste Override in 2 % Stufen oder stufenlos	74	0 – 7 Eingabewerte siehe Tabelle in Kapitel 6.1.2
Referenzsignal-Auswertung für die gesperrten Achsen	75	0 ≙ nicht aktiv 1 ≙ aktiv
Anzeige und Meßsystem-Überwachung für die gesperrten Achsen	76	0 ≙ nicht aktiv 1 ≙ aktiv
PC-Programm aus RAM oder aus EPROM	77	0 1
Drehzahlbereich Getriebestufen für S-Analog-Ausgabe 0	78	0 – 9.000,000 U/min
1	79	
2	80	
3	81	
4	82	
5	83	
6	84	
7	85	
S-Analogspannung bei S-Override auf 100 %	86	0 – 9,999 Volt
S-Analogspannung bei S-Override max. Ausgangsspannung	87	
Begrenzung des S-Override Maximum	88	0 – 150 %
Minimum	89	
Achskennzeichnung für Achse IV	90	0 ≙ A 3 ≙ U 1 ≙ B 4 ≙ V 2 ≙ C 5 ≙ W

Funktion	Parameter Nr.	Eingabe-Werte
Konstante Bahngeschwindigkeit bei Außenecken	91	0 – 179,999 Winkel in Grad
Dezimal-Zeichen in Programm Ausgabe über V.24	92	0 ≙ Dezimal-Komma 1 ≙ Dezimal-Punkt
Überlappungsfaktor beim Taschenfräsen	93	0,001 – 1,414
PC: Zähler-Vorgabewert für Zähler 0 – 15	94 bis 109	0 – 65 535 in Einheiten von 20 ms
PC: Timer Zeit für Timer 0 – 15	110 bis 125	0 – 65 535 in Einheiten von 20 ms
PC: Positionswerte für 31 Koordinaten 31 = Ref	126 bis 156	± 30 000,000 mm
Aktivierung der nächsten Werkzeugnummer	157	0 ≙ keine Ausgabe der nächsten Werkzeugnummer 1 ≙ Ausgabe nur bei der Änderung der Wkz.-Nr. 2 ≙ Ausgabe der nächsten Wkz.-Nr. bei jedem Werkzeug-Aufruf
Setzen von 16 Merkern auf Binärzahl	158	0 – 65 535
Automatische Schmierung nach programmierter Verfahrstrecke in X	159 bis 162	0 – 65 535 (in 65 536-µm-Einheiten)
Y		
Z		
IV		
Vorschubgeschwindigkeit für die Parameter Nr. 126 bis Nr. 156 X	163	80 – 15 999 mm/min
Y	164	
Z	165	
IV	166	
Anzeige des aktuellen Vorschubs vor dem Start in der Betriebsart **MANUELLER BETRIEB** (in sämtlichen Achsen gleicher Vorschub)	167	0 ≙ aus 1 ≙ ein
Rampensteilheit für S-analog	168	0 – 1,999 Volt/ms
Stillstands-Überwachung	169	0,001 bis 30 mm
Programmierplatz	170	0 ≙ Steuerung 1 ≙ Programmierplatz PC aktiv 2 ≙ Programmierplatz PC inaktiv
Handrad	171	noch nicht aktiv, 0 eingeben
Polarität S-Analogspannung	172	0 ≙ M 03: positive Spannung M 04 negative Spannung 1 ≙ M 03: negative Spannung M 04 positive Spannung 2 ≙ M 03 und M 04 positive Spannung 3 ≙ M 03 und M 04 negative Spannung
Löschen der Status-Anzeige mit M 02 und M 30	173	0 ≙ Status-Anzeige wird nicht gelöscht 1 ≙ Status-Anzeige wird gelöscht
Schleppfehler-Überwachung im geschleppten Betrieb		
Not-Aus	174	0 – 100 mm
löschbar	175	
Multiplikationsfaktor für den K_V-Faktor	176	0,001 – 1,000
K_V-Faktor für X	177	0,100 – 10,000
K_V-Faktor für Y	178	
K_V-Faktor für Z	179	
K_V-Faktor für IV	180	
Kennlinien-Knickpunkt	181	0 – 100,000 %
Minimum für Vorschub-Override beim Gewindebohren	182	0 – 150 %
Maximum für Vorschub-Override beim Gewindebohren	183	

Funktion	Parameter Nr.	Eingabe-Werte
Minimale Spannung für S-Analogausgabe	184	0 – 9,999 Volt
Wartezeit für das Abschalten der Restsollwert-Spannung bei der Fehlermeldung "Positionier-Fehler"	185	0 – 65,535 s
Werkzeugwechsel-Position M 92: X-Achse	186	± 30 000,000
Y-Achse	187	
Z-Achse	188	
IV-Achse	189	
Programmierung der Drehzahl S = 0 erlaubt (Spannungswert von MP 184 kann unterschritten werden)	190	0 ≙ S ≙ 0 erlaubt 1 ≙ S ≙ 0 nicht erlaubt
Anzeige der aktuellen Spindel-Drehzahl vor dem Start in der Betriebsart MANUELLER BETRIEB	191	0 ≙ keine Anzeige 1 ≙ Anzeige
Positionierfenster für die IV. Achse	192	0,001 – 0,05 mm
PC: Timer-Zeit für Timer 16 – 31	193 bis 208	0 – 65 535 in Einheiten von 20 ms
Unterstützung von PC-Makro-Befehlen	209 bis 212	0 0
Zyklus "Maßfaktor" wirkt auf 2 Achsen oder auf 3 Achsen	213	0 ≙ der programmierte Maßfaktor wird in den 3 Hauptachsen X, Y und Z berücksichtigt 1 ≙ der programmierte Maßfaktor wird in der Bearbeitungsebene berücksichtigt
Programmierter Halt bei M06	214	0 ≙ programmierter Halt bei M06 1 ≙ kein programmierter Halt bei M06